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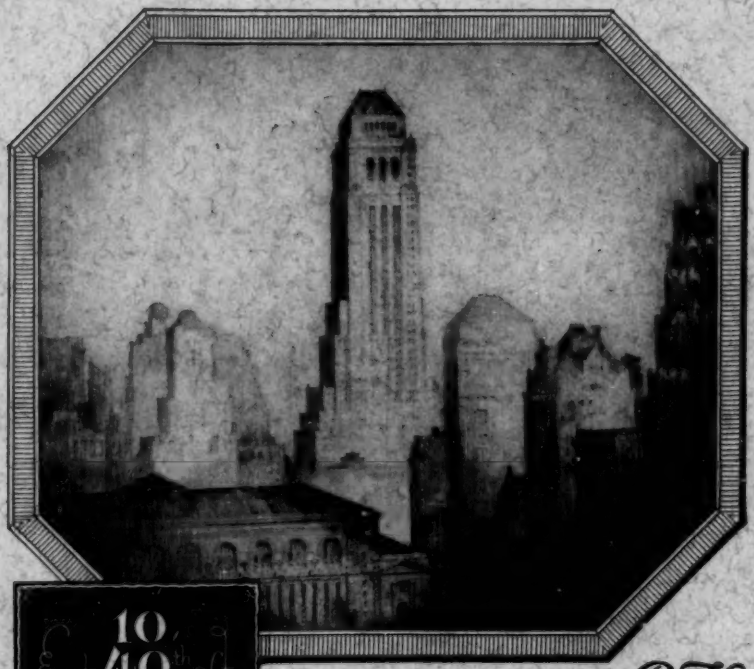

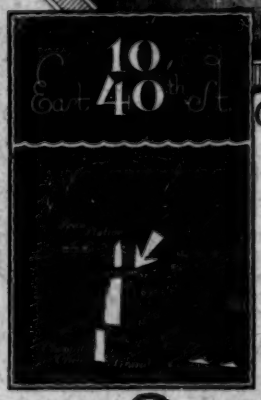

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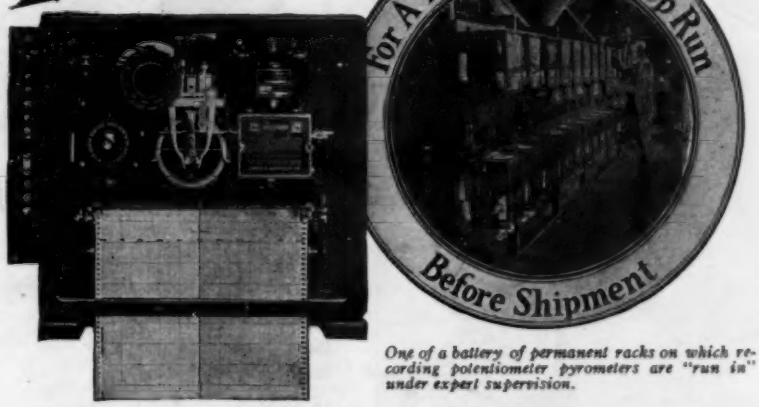

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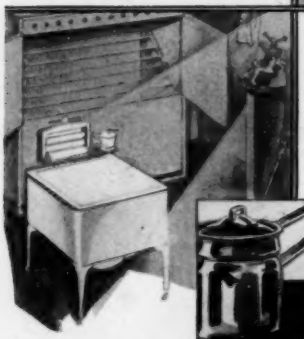

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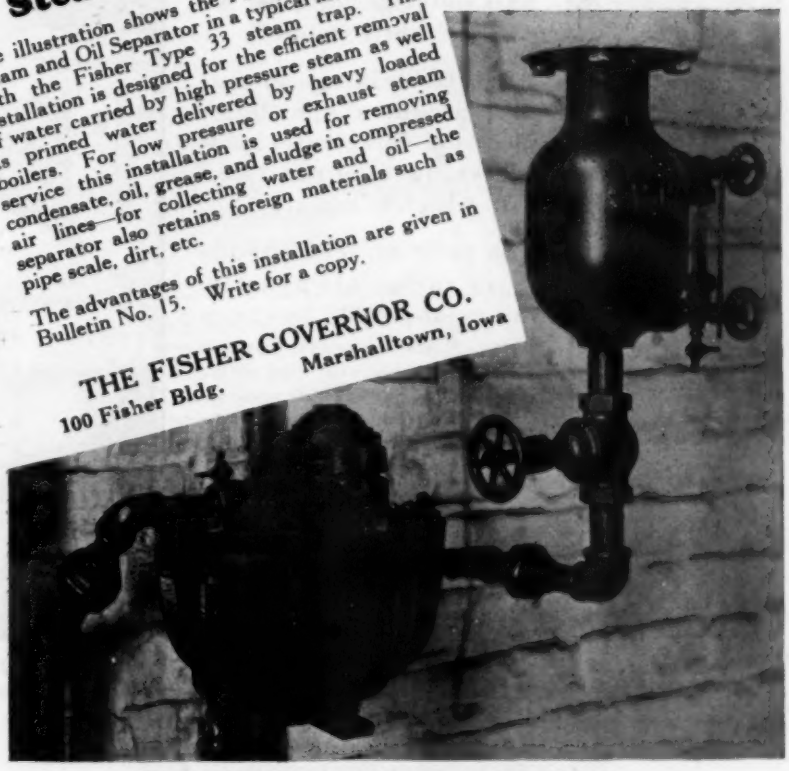

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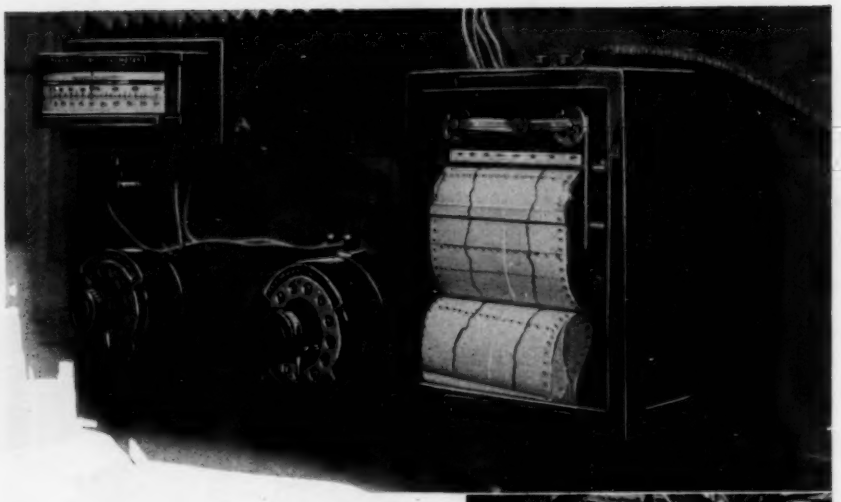

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THE COMPRESSIVE AND TRANSVERSE STRENGTH OF BRICK[1]

By J. W. McBurney[2]

ABSTRACT

This paper reports the compressive strength flat and on edge and the transverse strength of twenty-seven makes of brick covering a range of conditions in method of manufacture and degree of firing. The attempt is made to correlate the variation in ratios of these different measures of strength with the various structural features of the brick.

I. Introduction

In a previous paper[3] the author makes the following statement:

> The various measures of strength of brick, compressive flatwise and on edge, transverse, tensile and shearing, vary in their relation one to another for different makes of brick.

This statement was based upon the consideration of but five makes of brick. The purpose of the present paper is to present data representing a range of conditions and to determine if possible what are the factors influencing variation in relation of certain strength measures.

A secondary purpose is that of determining the degree of justification for the practice followed in certain specifications where but one of these strength measures (usually the transverse strength) is used. Apparently it is assumed either that the various strength measures are so related that one can serve as a measure of the others or that the one selected has a sufficiently close relation to the strength of the masonry to justify the omission of the other strength tests.

II. Review of Literature

Confining consideration to tests reported for the United States and Canada and taking them in chronological order the more important contributions where two or more strength tests of brick are compared are as follows:

Bleininger[4] reports 176 tests on brick collected in a district covering a radius of 150 miles from Washington, D. C. His values represent half brick tested in compression flatwise and edgewise. He states that "the

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received December 20, 1928. Publication approved by the Director of the Bureau of Standards, U. S. Dept. of Commerce. Published simultaneously with *Journal of the Bureau of Standards.*

[2] Research Associate for the Common Brick Mfrs. Assn. of America at U. S. Bureau of Standards.

[3] "The Effect of Strength of Brick on Compressive Strength of Brick Masonry," *Proc. A.S.T.M.*, **28** [2], 605–25 (1928).

[4] A. V. Bleininger, "The Relation between the Porosity and Crushing Strength of Clay Products," *Trans. Amer. Ceram. Soc.*, **12**, 564–84 (1910).

brick tested were of the harder grade and practically all of them were made by the stiff-mud process. Both shale and clay brick are represented." No information was provided as to whether given specimens were side-cut or end-cut nor was information provided as to laminar structure. On the basis of these 176 tests, the average ratio of compressive strength flat to compressive strength on edge is given as 1.153 and "individual tests vary widely from the average ratio...." From an inspection of Bleininger's graph it is evident that there is much less scattering of ratios for the clay brick than for the shale brick. He stated in the discussion:

> Some of the end-cut brick were stronger when tested on edge than when subjected to the load in the flat condition. Most of the side-cut brick showed the opposite to be the case.

Ries[5] reports results of compressive flat and on edge and transverse tests on sixteen makes of brick. These brick are classified as dry-press, soft-mud, and stiff-mud manufacture.

Committee C3 on Brick of the American Society for Testing Materials[6] in its report for 1915 presents results of compression tests flatwise and transverse tests of brick. Unfortunately, the data as to method of manufacture are incomplete. Williams[7] reported 14 sets of tests on soft-mud and 20 sets of tests on stiff-mud brick. These test values are for compressive strength on edge and transverse strength.

Orton[8] reports an elaborate series of comparisons between the compressive strength of half brick tested flatwise and edgewise.

III. Source of Samples

Table I gives values for the transverse strength, compressive flatwise strength, and compressive edgewise strength of 27 makes of brick, arranged according to method of manufacture.

Samples 2A, 6, 13A, and 14A represent random samplings from large shipments. It will be noted that for these the number of specimens tested are fifty or more. The values for Samples 7 and 17A are the averages from tests of fifty specimens selected from shipments of 300 bricks of each type. The rest of the specimens represent samples of a few brick each supplied by the manufacturer. In all cases, however,

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[5] H. Ries, "Results of Tests on Some Bricks from the Province of Western Canada," *Trans. Amer. Ceram. Soc.*, **14**, 82–86 (1912).

[6] *Proc. A. S. T. M.*, **15** [1], 150–62 (1915).

[7] Ira A. Williams, "Strength Tests of Oregon Building Brick," *Trans. Amer. Ceram. Soc.*, **17**, 660 (1915).

[8] Edward Orton, Jr., "A Comparison between the Absorption, Crushing Strength, and Resistance to Freezing of Some Ohio Building Brick," *Ibid.*, **18**, 686–760 (1916).

TABLE I

TRANSVERSE AND COMPRESSIVE STRENGTHS OF BRICK

Sample no.	No. of tests	Method of manufacture	Mod. of rupture (lbs./sq. in.)	Comp. strength half brick (lbs./sq in.)		Ratio		
				Flat	Edge	Mod. of rup. to comp. flat	Mod. of rup. to comp. edge	Comp. flat to comp. edge
1	3	D.P.	1126	5760	5413	0.195	0.218	1.06
2A	98	"	800	3520	3630	0.227	0.220	0.97
2B	5	"	141	1860	1142	0.070	0.123	1.62
3	4	"	2020	18980	11700	0.106	0.173	1.62
4A	3	S.D.P.	852	7710	7220	0.111	0.118	1.07
4B	3	"	887	7300	7300	0.121	0.121	1.00
4C	3	"	293	2430	2470	0.120	0.119	0.985
5	5	S.M.	515	2720	3032	0.189	0.170	0.900
6	50	"	670	3320	3360	0.201	0.200	0.990
7	50	"	489	3110	3169	0.157	0.155	0.982
8	3	"	765	3270	3630	0.234	0.211	0.900
9	3	"	730	4215	3730	0.173	0.196	1.13
10	1	"	1170	7000	7450	0.168	0.157	0.940
11	1	"	510	3850	4520	0.132	0.113	0.853
12	1	"	500	1990	2280	0.251	0.219	0.877
13A	100	"	1550	8610	11600	0.180	0.134	0.742
13B	6	"	349	1917	2240	0.182	0.160	0.856
14A	94	S.M.E.C.	1320	3370	3780	0.392	0.349	0.891
14B	7	"	685	2710	2040	0.251	0.336	1.33
15	5	"	1295	3040	3190	0.426	0.406	0.953
16A	5	"	947	6910	7200	0.160	0.131	0.960
16B	5	"	1250	6550	6780	0.191	0.184	0.965
16C	4	"	418	2350	2100	0.178	0.199	1.12
17A	50	S.M.S.C.	1573	10170	9104	0.154	0.173	1.12
17B	11	"	776	6093	5380	0.127	0.144	1.13
18	6	"	2130	14100	10750	0.151	0.198	1.32
19A	5	"	2834	11260	10340	0.151	0.175	1.09
19B	5	"	1234	13780	10440	0.090	0.117	1.33
20	2	"	1477	8085	7415	0.183	0.200	1.09
21	25	"	2890	22600	18950	0.128	0.153	1.19
22A	5	"	1864	5950	5560	0.314	0.335	1.07
22B	5	"	1170	4040	4070	0.290	0.288	0.944
23A	2	"	603	8100	3585	0.074	0.168	2.26
23B	3	"	721	5990	3816	0.120	0.189	1.57
23C	3	"	307	3546	2030	0.087	0.151	1.75
24A	3	"	3230	21200	14200	0.152	0.227	1.49
24B	4	"	987	6250	5890	0.158	0.168	1.06
25	1	"	1320	7940	9500	0.166	0.139	0.835
26	1	"	1020	6570	5750	0.155	0.177	1.14
27	1	"	790	3270	3470	0.242	0.228	0.942

D.P. = Dry press
S.D.P. = Semidry press
S.M. = Soft-mud
S.M.E.C. = Stiff-mud end cut
S.M.S.C. = Stiff-mud side cut

each sample number is confined to a single grade of a given manufacturer. None of the samples represents "run-of-kiln."

The data of Table I represent tests made by the author at the U. S. Bureau of Standards.

IV. Methods of Testing

The Tentative Methods of Testing Brick (C67–27T) of the American Society for Testing Materials were followed. The half brick from the transverse test were used in the compressive tests, one of the two halves from each brick being tested flatwise and the other on edge. Where the transverse test gave a break which was oblique or otherwise irregular, the halves were trimmed by cutting or grinding.

V. Description of Test Specimens

Dry-Press Brick

(1) Well made and free from lamination. Sample supplied by manufacturer and represented "well fired" color range, dark to light.

(2A) Random samples from shipment of 52,000 "commons." Granular texture, no laminations. Color reddish brown, surface clay.

(2B) Samples supplied by the manufacturer of 2A, but quite underfired salmons. Weak and friable. Color pink to orange.

(3) This sample represents an experimental dry-press brick formed and fired at the plant of a brick machinery manufacturer. Samples 19A and 19B represent the same shale and, in the opinion of the plant superintendent, 19A represents the same degree of vitrification as 3.

Semidry Press Brick

(4A) "Arch" or "clinker." Very considerably cracked and crazed. The cracks were apparently kiln cracks, since samples 4B and 4C were comparatively free from them. Some warpage.

(4B) "Body" brick corresponding to 4A. Much less evidence of kiln cracking. Good red in color.

(4C) The salmon of this manufacture. Orange in color.

Soft-Mud Brick

(5) Manufacturer's sample representing a considerable range of color. Some kiln cracking and warping.

(6) Random sample representing 18,000 "select common"; occasional nodules. The harder fired brick (as judged by color) frequently showed kiln cracks normal to the long axis of the brick.

(7) Sample represents random sampling of shipment of 300 "select common." Brick characterized by a sandy core and numerous lime nodules in size up to three-quarters inch in diameter. It may be of interest to note that salmons corresponding to Sample 7 were provided, but expansion of the nodules disrupted the specimens during drying. About one-third of specimens tested showed cracks.

(8) "Typical common brick of district" in judgment of building inspector. Resembles Sample 6 in appearance. Some irregular laminar structure.

(9) Also considered "typical common brick." Very fine grained. Some small nodules. No noticeable laminar structure.

(10) One specimen. Nodules and cavities evident on examining cross-section.

(11) One specimen Gave a very oblique break when tested transversely.

(12) One specimen. Nothing noted in way of lamination, nodules, or cavities.

(13A) Sample from shipment of 52,000 bricks. It was impossible to distinguish any granular or laminated structure. Appearance as of a fused body. Core colors different from outer portion of brick were quite common. Colors dark.

(13B) Salmons of 13A light orange. Weak. Original clay grains easily distinguishable.

Stiff-Mud End Cut

(14A) Double column. Due to lamination gave the appearance of being made of bundles of fibers running parallel to long axis of brick. Frequently on compression a circular core extending the length of the brick would result from spalling of the sides. Black cores were common. The brick itself, aside from its structure, gave some evidence of being rather hard. Large lime nodules were common.

(14B) The "unmarketable salmon" of 14A. There was very little to distinguish it in appearance from 14A. Noticeably weaker.

(15) A manufacturer's sample. Sample 15 is indistinguishable in appearance and properties from 14A. It comes, however, from a different district.

(16A) "Rough hard" which is the local name for "the arch" or "clinker" brick of other districts. This brick showed much cracking, crazing, and warping, probably due to overfiring. Little evidence of lamination. Such lamination as existed gave planes parallel to the broad face of the brick.

(16B) The "straight hard" or "body" brick corresponding to 16A. Good red and free from cracking and crazing characterizing 16A. Slight lamination as in 16A.

(16C) The salmon of the two preceding samples. Color was characteristic of that which gave the name salmon. No cracking or crazing and otherwise resembled 16B.

Stiff-Mud Side Cut

(17A) Random sample of 50 from manufacturer's sample of 300. Well-made shale. Granular structure, no evidence of lamination. The entire sample was remarkably uniform in all its properties.

(17B) The salmon of 17A. Resembles 17A except for color and strength.

(18) Well-made characteristic shale. No evidence of lamination.

(19A) Manufacturer's sample. Same shale and, in opinion of manufacturer, same firing history as Sample 3. No evidence of lamination.

(19B) Another sample from maker of 19A. From evidences of color and comparative water absorption 19B was not as hard fired as 19A.

(20) Manufacturer's sample "common." No lamination evident. Shale brick, but from color and water absorption apparently not very hard fired.

(21) Manufacturer's sample of "hard shale commons." No laminations. Degree of firing such that granular structure was practically suppressed.

(22A and 22B) Together represent a vertical section of a downdraft kiln. 22A is the top half, 22B the lower half. From color and water absorption the grading is obvious. The structure is granular with an appearance of what might be called internal crazing, small, short cracks at irregular intervals and direction. Shale.

(23A) Manufacturer's sample of "clinker." Black glazed exterior, red interior. This and Samples 23B and 23C were outstanding examples of die lamination. Apparently an imperfect mixture of two clays existed and the laminar structure was very noticeable. Aside from lamination Sample 23A showed the cracking, crazing, and warping usually associated with clinker brick.

(23B) The body brick corresponding to 23A. Highly die laminated, not so irregular as 23A.

(23C) The salmon corresponding to the two preceding samples. Also laminated but little cracked.

(24A) Manufacturer's sample offered as "face." These represent the top portion of the kiln. Hard fired, unlaminated shale.

(24B) Lower portion of kiln. Marked "fillers" by manufacturer. Salmon color, otherwise description of 24A applies.

(25) One specimen, side-cut clay. Some nodules, no lamination evident.

(26) One specimen. Some irregular lamination (auger), clay.

(27) One specimen, clay, sandy texture, no lamination.

VI. Discussion of Results

(1) Relation of Compressive Strength Flatwise to Compressive Strength Edgewise

Assuming that brick behaves like the Swiss sandstone tested by Bauschinger,[9] the ratio of compressive strength flatwise to compressive strength edgewise would be 1.26. Actually the data here presented show a wide

[9] Johnson's Materials of Construction, 6th Ed., pp. 113–14.

variation. The two extremes for this ratio are 0.74 for Sample 13A and 2.26 for Sample 23A. It is obvious that the structure of the brick is responsible for this variation, hence it is in order to examine these data for the purpose of seeing whether there is any correlation between the structure of the brick and the ratio of compressive strength flatwise to compressive strength edgewise.

Referring to the descriptions of the samples it will be observed that the following data have been recorded:

(A) Method of manufacture.
(B) Kind of raw materials, clay, or shale.
(C) Presence or absence and character of laminations and cracks.
(D) Presence or absence and character of nodules or other inclusions.
(E) Character of texture, *i.e.*, granular, glassy, etc.
(F) In some cases degree of firing is noted.

In the opinion of the writer too much weight should not be given to differences within 10% where the samples are small, due to the large variation in results due to sampling.

Effect of Method of Forming

Considering the effect of method of forming on the ratio compressive strength flatwise to edgewise, it would appear on the basis of the very limited series of dry-press specimens that the range for this ratio is from unity up to 1.6. Increase in the ratio appears to be produced by pronounced underfiring (note Sample 2B in comparison with 2A). No obvious explanation is noted for the high ratio of Sample 3. It has been observed that excessive pressure in forming a dry-press brick will produce laminations or planes of weakness normal to the direction of the pressure. The results of Ries[5] give a range of from 1.06 to 1.72 for five samples of dry-press brick.

The semidry-press samples are close to unity for their ratio. The fact that the arch brick (4A) is somewhat stronger flat than on edge would seem explainable by its cracked and crazed structure.

The soft-mud samples with one exception (No. 9) were all stronger on edge than flat.

The eight samples of soft-mud brick reported on by Ries[5] were stronger on edge than flatwise. The five samples reported by Orton[8] gave ratios varying from 0.93 to 1.18 for the hard and medium firings. It is evident from the data here presented that soft-mud brick tend toward a lower ratio than characterizes the other methods of manufacture. Why this should be is not apparent. Soft-mud brick are formed by light pressure in a mold at semiliquid consistency. No laminar structure or planes of weakness should be formed. They should show the effect of change in ratio of cross-section to height to give greater strength flatwise than

edgewise. The only explanation that comes to mind is that these brick are fired on edge and the pressure of the brick may produce a consolidation in the line of the applied forces giving greater strength on edge than on flat. This possibility will be mentioned again in connection with the discussion of effect of degree of firing on the compressive strength ratio. Like the soft-mud brick, the well-fired stiff-mud end-cut brick were generally stronger on edge than on flat. The salmon stiff-mud end-cut show the reverse of this.

The characteristic of side-cut brick is that of being stronger flat than on edge. In general, the data of Orton and Ries confirm this.

Effect of Kind of Raw Material

It is not considered that these data are sufficient to warrant any conclusions as to differences between clays and shales which may affect the ratio of compressive strengths flat to compressive strength on edge. It should be remembered that the type of raw material is usually the consideration that determines the method of forming.

Presence and Character of Laminations and Cracks

Considering the same clay molded by different processes, the presence or absence of laminations in various degrees is largely a result of the methods of manufacture. Soft-mud brick should be practically free from lamination. Stiff-mud brick may be substantially free from laminations or may have a highly laminar structure. Dry-press brick may develop planes of weakness normal to the direction of the applied pressure, when improperly pressed.

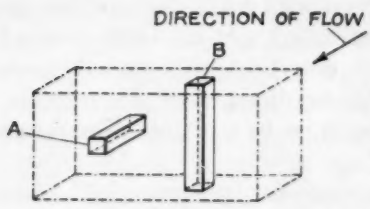

FIG. 1.

Considering a laminated side-cut brick, the flow of material in the die is normal to the large face. Hence the planes of lamination would in general be normal to the large face. It would appear reasonable to expect that a small prism such as A in Fig. 1 would have a greater strength than B due to the compacting of the grains in the case of prism A and their separation due to differential flow in the case of prism B. It is conceived that firing on edge may have an effect toward overcoming this tendency, which may explain the occasional reversal of the ratio. The presence of irregular cracking and crazing such as frequently characterize clinker brick would seem to offer an explanation of high ratios of flat to edge compressive strength. Surface cracks would be expected to have a greater effect on the compressive strength when the brick were tested on edge, because the portions cracked would occupy a greater percentage of the sectional area than when the brick were tested flatwise.

Effect of Nodules Presence or absence of nodules does not appear to have any definite effect on the relation between the two compressive strengths. It is possible, however, that if a nodule, inclusion, or core were of a size such that it represented a considerable portion of the cross-section of the brick and were of a different strength, then an effect would be produced on the relative compressive strength flatwise to edgewise by the difference in percentage of the two materials effective for the two cross-sections. Figure 2 shows schematically a cross-section normal to the long axis of Sample 13A. The core in this case is due to lack of complete oxidation. Assuming that the outer portion A is stronger than the inner portion B, it is evident from the diagram that a greater percentage of the cross-section along the line x - - - - - - - x_1 is of material A than is the case for the cross-section y - - - - - - - y_1. If this difference in strength exists, this would appear to explain the low ratio (0.742) for Sample 13A.

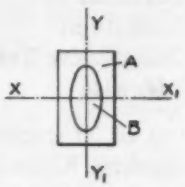

FIG. 2.

Character of Texture The character of the texture does not appear to be related to variation in the ratio of the two compressive strengths. In general, a vitreous structure is associated with high compressive strength and an open, granular, poorly-bonded structure has low strength. But extremes of ratios are associated with both types of structures.

Degree of Firing A casual inspection of the data where the product of the kiln is classified into arch, body, and salmon or where the sample represents a vertical section of the kiln and classification was made by position, seemed to indicate a very marked effect on ratios of compressive strength by degree of firing. In some cases, however (2A and 2B, 13A and 13B, 14A and 14B, 16A, 16B, and 16C), the effect was for the underfired brick to have higher ratios of compressive strength flat to edge. In other cases (22A and 22B, 24A and 24B) the direction of change was reversed. In yet other cases there was no significant difference in the ratios (4A, 4B, and 4C, 17A and 17B) or the order was mixed (23A, 23B, and 23C).

The suggestion, however, that the firing of brick on edge might add to their apparent compressive strength on edge by the effect of the weight of the superimposed brick during firing does much to explain these data. Samples 2, 13, 14, and 16 represent brick from scove kilns. The salmons from scove kilns come from the top and outer portions of the kilns. They represent specimens that have been subjected to relatively little pressure in firing. Samples 22 and 24 are from downdraft kilns. Here the salmons are from the bottom of the setting. Samples 4 and 16 are from small scove kilns and the clinker specimens are both quite cracked and

crazed. Sample 17 was fired in a downdraft kiln but the location of the specimens is unknown. The type of kiln used for Sample 23 is also unknown. In any case the higher ratio of the clinker brick is explainable by its cracked and crazed condition.

Character of Fracture in Compressive Tests Edgewise

Before leaving the subject of tests in compression it is desired to introduce some data dealing with the apparent relation between compressive strength and type of fracture.

Table II gives an analysis of the data secured on a test of 50 specimens of Brick 2A, the samples being whole brick tested edgewise. The type of fracture, as indicated on the end of the test specimen, was recorded at the time of test.

Table II gives clearly the fact that a double shear (cone or wedge) is associated with a higher compressive strength than where the failure takes place in a single diagonal shear. This fact alone could be explained by assuming that the ten tests which gave the higher strength and double shear were concentrically loaded while the thirteen tests which failed in single diagonal shear with low strength were eccentrically loaded. The fact, however, that the difference in strength is actual and not due to difference in loading is vouched for by the inverse relation of the water absorption. The possibility exists that eccentric loading was present for both types of fractures, but the stronger brick were better able to resist the effect of eccentricity.

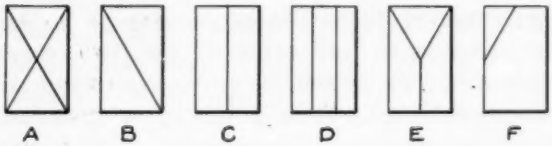

FIG. 3.

TABLE II, BRICK 2A
TOTAL NUMBER OF SPECIMENS, 50

Number of tests	Compressive strength, whole brick on edge (lbs./sq. in.)	Water absorption, 5-hour boil (%)	Type of break (See Fig. 3)
50	3300	22.26	All types
10	4100	21.29	A
13	2470	23.95	B
27	3400	21.80	C, D, E, F

(2) Relation of Transverse to Compressive Strength

The ratios of modulus of rupture to compressive strength flat given in Table I range from 0.426 to 0.070. The transverse strength is notably quite sensitive to imperfections in the brick. Usually it will be found that where a series of brick is tested, the percentage deviation from the mean of the modulus of rupture will exceed the percentage deviation from the

mean of the compressive strength. In other words, nodules, slight laminations, or other planes of weakness will very noticeably reduce the transverse strength.

Effect of Method of Manufacture As would be expected soft-mud brick were the most constant in this ratio. Nodules are the principal interfering factor likely to be present. The ten ratios given in Table I range between 0.132 and 0.251. Fourteen values given by Williams[7] range from 0.171 to 0.256.

The ratios for dry-press brick range from medium values, 0.227 down to 0.070.

The ratios for stiff-mud end-cut range from medium values to 0.426.

For stiff-mud side-cut brick the ratios differ rather widely going from 0.074 to 0.314.

Effect of Type of Raw Material If there is any consistent effect on the relations between transverse and compressive strength due the use of shale or clay, it is obscured by the variation in other factors.

Effect of Lamination and Cracks Not only do laminations exercise the obvious effect of lowering the ratio modulus of rupture to compressive strength, but in certain cases they are believed to be responsible for raising the ratio. Samples 14A and 15 are considered examples of this effect. They were both double column, end-cut brick and were auger laminated to a very considerable degree. The net result was to produce a tubular structure. From analogy to the strength of a metal tube acting as a beam and the strength of a metal tube in compression normal to its axis, as compared to the corresponding strengths of a solid shaft of the same diameter, this explanation of the high ratio of transverse to compressive strength for these brick seems warranted. Samples 23A, 23B, and 23C are illustrations of laminar structure acting to lower this ratio.

Kiln cracking normal to the long axis of the brick is, of course, a sure way to lower the transverse strength.

Effect of Nodules From observations of the tests of soft-mud brick it is believed that a heterogeneous section, the visible evidences of which are nodules, has much to do with moderate variation in the ratio modulus of rupture to compressive strengths. The effect of texture is uncertain.

Effect of Variation in Firing No definite effect on modulus of rupture and compressive strength ratio seems to be produced by variation in firing. The salmon brick are usually not far from the well-fired brick in ratio. Samples 2A and 2B provide a notable exception. The clinker brick are usually low in ratio, probably explainable by their cracking and crazing.

Specification Requirements

In the words of Orton:

> We cannot safely translate data made by crushing on the flat into terms of crushing on the edge, except in large masses or averages, and here with many reservations.

These data, in the writer's opinion, give no justification for the belief held in some quarters that the B grade of the Tentative Specification for Building Brick (C62–27T) of the A.S.T.M. is necessarily the equivalent of the medium grade of the former Standard Specification for Building Brick (C21–20) of the A.S.T.M. Grade B (C62–27T) gives compressive strength flatwise as 2500 to 4500 lbs. per sq. in. Grade medium (C21–20) gives compressive strength edgewise as 2000 to 3500 lbs. per sq. in. The equivalence of these two grades is certainly not true for soft-mud brick and only occasionally fits certain kinds of stiff-mud brick.

The data on transverse strength compared with compressive strength likewise give no warrant for assuming any general relation between the measures of strength such as would be expected for isotropic and homogenous material. The fact that a given ratio may be the average for a very large number of tests does not increase the probability that the average ratio will represent the actual ratio for a particular kind of brick. As an extreme illustration consider a field occupied by an equal number of cattle and horses. The statement that the animals in that field have on an average one horn apiece illustrates the fallacy of attempting to average separate categories. The practice of plotting one measure of strength against another measure of strength where a wide scattering exists, as in the present data, and then drawing a line by least squares to represent the "most probable" relation would be valid if the scattering of the points represented "error." To illustrate: Sample 14A is typical of that clay and method of manufacture. Repeated tests confirm its high ratio (0.392) quite closely. The fact that Brick 14A has a high modulus of rupture along with a comparatively low compressive strength is not chance. It is the nature of that brick. Hence, taking a ratio based on averages of all bricks does not represent the truth concerning this particular kind of brick.

The application of this to specification writing is that brick is purchased as the product of a given manufacturer. If a given property (*i.e.*, a certain flat compressive strength) is desired, that property should be asked for, not another property assumed to be related to the wanted property by a presumably fixed ratio.

VII. Summary

From the data and discussion here given the following conclusions are believed warranted as far as they are limited to brick made of shale or clay.

(1) The ratio compressive strength of brick flat to compressive strength of brick on edge ranged from 0.74 to 2.3.

(2) The tendency of soft-mud brick was to give higher unit strengths tested on edge than when tested flat.

(3) The "compacting effect" on the structure of the edge-set brick by the superimposed weight of the other brick in the kiln is offered as a tentative explanation of the tendency toward higher strength on edge.

(4) This tendency toward higher strength on edge is overcome by laminar and cracking structure in the case of certain brick.

(5) The ratio of modulus of rupture to flat compressive strength ranged from 0.426 to 0.070.

(6) Soft-mud brick tend to display less deviation in the ratio modulus of rupture to flat compressive strength than any of the other methods of manufacture, but even with these the ratio ranged between 0.13 and 0.26.

(7) Auger lamination in end-cut brick appears to be associated with high ratios for modulus of rupture to flat compressive strength.

(8) Die lamination in side-cut brick appears to be associated with low ratios for modulus of rupture to flat compressive strength.

(9) In view of the variation in the ratio compressive strength flat to compressive strength on edge, there exists no general rule for converting values from one kind of test to the other kind.

(10) In view of the variation in the ratio modulus of rupture to compressive strength flat the possibility of inferring a compressive strength from a transverse test or *vice versa* is open to very large errors for any given make of brick.

Acknowledgment The author acknowledges his indebtedness to the various members of the staff of the U. S. Bureau of Standards who gave assistance and counsel in the preparation of this paper. Particular thanks are due to R. T. Stull for his suggestions drawn from his plant experience.

Acknowledgment is made of the assistance rendered by the various manufacturers who generously provided samples and information.

MASONRY FAILURES DUE TO VERTICAL SHEAR[1]

By Fred T. Heath

ABSTRACT

Observations and analysis of masonry failures are presented in which vertical cracks result from shear. It is suggested that the scope of laboratory testing of masonry walls be broadened to include a study of vertical shear stresses, and that general conclusions regarding masonry strength take such tests into consideration.

Introduction

Practically all of the tests that have been conducted on the strength of masonry have been based on the assumption that masonry walls are uniformly loaded. The many conclusions reached regarding the strength of masonry are, in reality, primarily in reference to masonry walls that are uniformly loaded. As far as can be learned, the only deviations from the orthodox procedure of uniform loading have been a comparatively few walls loaded over their entire bearing area, but the loads applied eccentrically, as abstracted in the summary which follows. These few tests are significant in showing that the method of loading is an extremely important factor to be considered in a broad conception of the practical strength of masonry.

Summary of Previous Investigation

Eight conclusions are given by J. G. Bragg[2] based on the results of the investigation and a study of previous tests, of which the first two are:

The primary failure of brick piers is caused by a transverse failure of the individual bricks.

The ultimate strength of the pier may be increased by any method of construction which will increase the depth of the component parts of the pier. This may be done by (1) laying the bricks on edge instead of flat, (2) breaking joints every few courses instead of every course, or (3) using bricks of more than ordinary thickness.

In the 1925 Report of the Building Code Committee,[3] paragraph 13 of the Appendix treats of the elements affecting strength of brickwork:

Indications are that the different processes used in making clay brick influence its modulus of rupture more strongly than its crushing strength. In the course of recent compressive tests on brick walls the headers broke first in almost every case, indicating that the modulus of rupture is an important element in determining the strength of brick masonry . . . . it is admitted that the transverse test is a better indication of quality than has generally been held.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Illinois, February, 1929. (Heavy Clay Products Division.) Received Dec. 29, 1928.

[2] "Compressive Strength of Large Brick Piers," Bur. Stand., *Tech. Paper*, No. 111 (1918).

[3] "Recommended Minimum Requirements for Masonry Wall Construction." Report of Building Code Committee, Bureau of Standards, U. S. Department of Commerce, 1925.

The manner of loading is also tabulated as an element affecting strength:

> Experimental data indicate a sharp decrease in bearing capacity when loading is eccentric.... Available data are not complete enough to justify detailed conclusions, but indicate strongly that eccentricity must be considered and that its influence may be computed quite closely by accepted rules of mechanics.

Of the 708 tests reported in 1926,[4] 697 were uniformly loaded piers or walls and only in 11 cases were the loads eccentric. Two of these 11 walls were included in a program conducted at the University of Illinois Engineering Experiment Station in 1907 by Talbot and Abrams. The brick piers were 12 inches square and 10 feet high, and the mortar was 1 part Portland cement and 3 parts sand. The load was 1 inch eccentric and the ultimate crushing strength averaged 2800 lbs. per sq. in. Three piers similar in every respect, but loaded concentrically, developed ultimate crushing strengths averaging 3367 lbs. per sq. in.

H. Kreuger tested walls eccentrically loaded in 1915 at Technical High School, Stockholm, Sweden. These were three piers 9 inches square and approximately 2 feet 9 inches high, built with a lime mortar. The load was applied at the quarter point, giving an average ultimate crushing strength of 612 lbs. per sq. in. Three companion walls loaded concentrically tested to 1320 lbs. per sq. in.

The only other mention of walls loaded other than concentrically in this elaborate report pertains to six 8-inch walls, 6 feet long and 9 feet high, included in the series tested by A. H. Stang in 1920–21 at the Bureau of Standards, Pittsburgh. These walls were built with a lime-cement mortar, three of them solid brick masonry and three of them hollow walls, "Ideal." The solid walls loaded eccentrically at the quarter point developed 410 lbs. per sq. in. as compared with similar walls loaded concentrically which tested to 543 lbs. per sq. in. In the case of the hollow walls, those loaded at the quarter point tested 507 lbs. per sq. in., as compared with three companion walls, uniformly loaded, which developed ultimate crushing strengths averaging 547 lbs. per sq. in.

In tests of hollow tile walls,[5] one-fourth of the 72 walls tested were loaded with an eccentricity of 2 inches. These included both 8-inch and 12-inch walls, 6 feet long and 9 feet high, constructed with lime-cement mortar. A conclusion of the paper states:

> On the average the loads supported by the eccentrically loaded walls were 60% as great as those supported by the similar walls centrally loaded.

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[4] "Compression Tests on Brick Masonry," a compilation of data covering 708 individual tests of brick masonry in the form of piers and walls. Prepared by the Building Code Committee of the U. S. Department of Commerce, 1926.

[5] A. H. Stang, D. E. Parsons, and H. D. Foster, "Compressive and Transverse Strength of Hollow-Tile Walls," Bur. Stand., *Tech. Paper*, No. 311 (1926).

J. W. McBurney[6] says in a recent paper:

> The data were secured in the testing of 186 brick walls where five different makes of brick were used. The five makes of brick were tested in compression flatwise and edgewise, in transverse bending, in tension, and in shear. Ratios of these various brick strengths to both maximum compressive strength and strength at first crack of the walls were calculated.

All walls of this test program were uniformly loaded over their entire area.

> Comparison of ratios where workmanship, strength of mortar, and type of construction were the same indicate that the compressive strength of brick tested flatwise gives the most uniform relation to strength of masonry.

Observations of Construction Failures

The photographs are records of observations of failures in masonry. In each of the ten typical cases there are two views, A and B, the A series showing the entire building and the B series showing in detail the failure observed. The location of the close-up B views is outlined on the A views.

All the examples of failures that have been observed appear to be due to shear. It is possible that masonry walls fail in direct compression, but such cases are rare and naturally result in damage that must be repaired.

The failures illustrated are all of one type and become evident as vertical cracks. These are typical of a great many failures of this general kind which have been observed. Quite frequently vertical cracks similar to these can be observed, but there has been so little movement of the masonry following the failure that the cracks are difficult to perceive, and for this reason are not apparent in photographs. For instance, Fig. 10B shows a crack extending vertically from the joint in the stonework and traversing three of the brick courses. This crack would be difficult to observe either in the actual building or in the photo unless specifically pointed out. Therefore, with the exception of Fig. 10, the views selected are all of failures in which the cracks have opened up sufficiently that clear illustrations result.

Statement of Failures

In making an analysis of these failures, the theory of shearing stress is based primarily on the observations of failures such as Fig. 10 in which there are no indications of foundation settlement or other perceptible wall movements. Very likely uneven foundation settlement contributes to most of the failures illustrated, but such movements are not necessarily the initial cause of failure.

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[6] J. W. McBurney, "The Effect of Strength of Brick on Compressive Strength of Brick Masonry." Published by the American Society for Testing Materials, 1928.

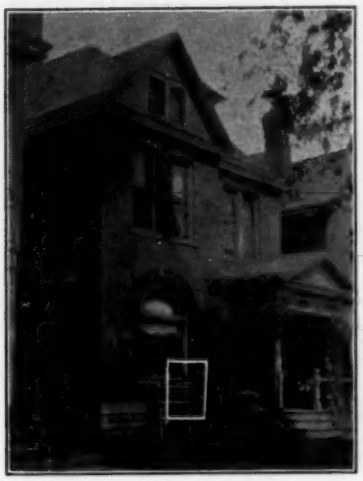

FIG. 1A.

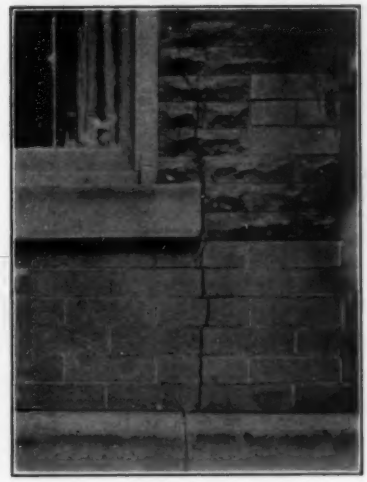

FIG. 1B.

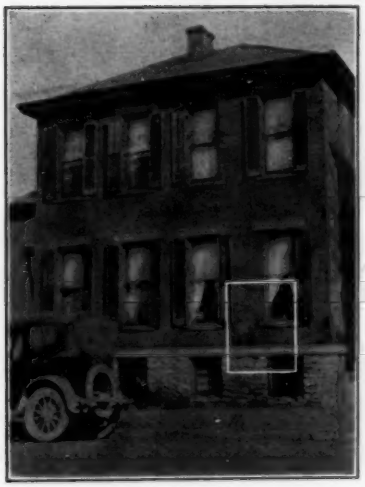

FIG. 2A.

FIG. 2B.

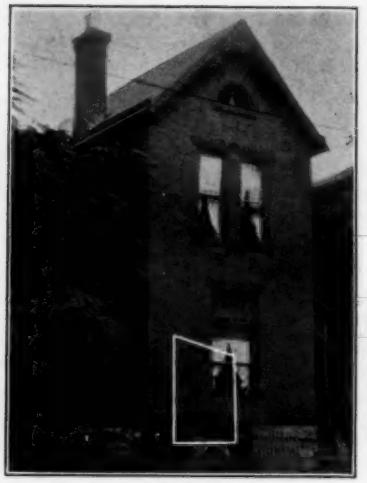

FIG. 3A.

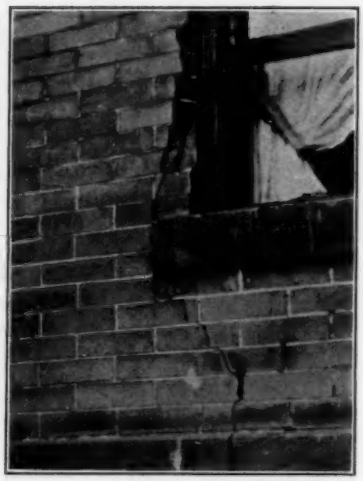

FIG. 3B.

FIG. 4A.

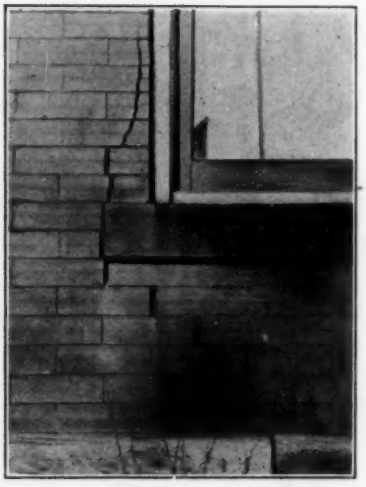

FIG. 4B.

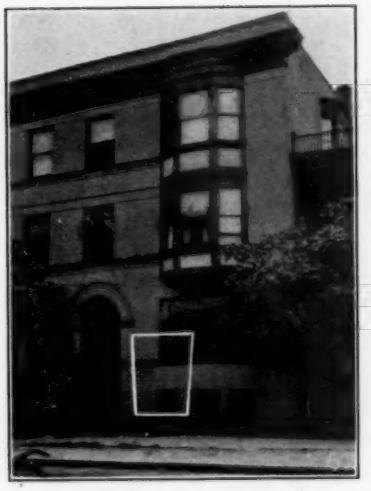

FIG. 5A.

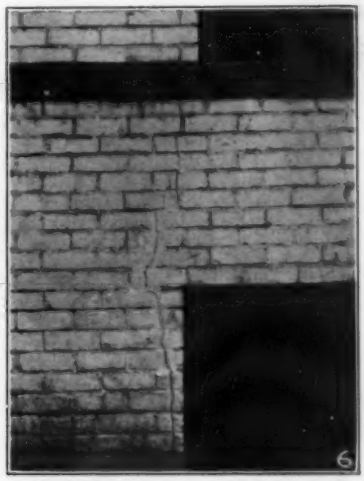

FIG. 5B.

FIG. 6A.

FIG. 6B.

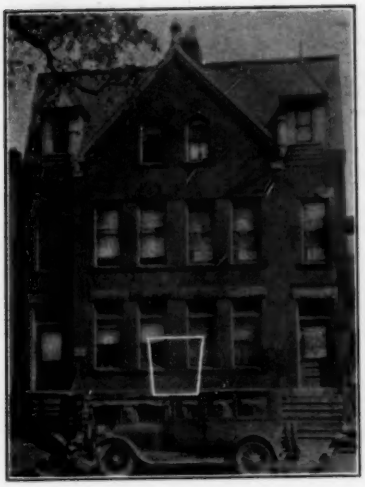

FIG. 7A.

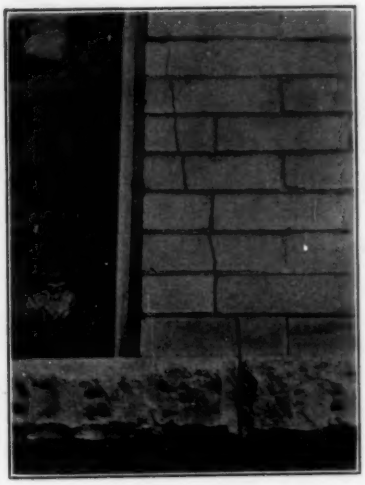

FIG. 7B.

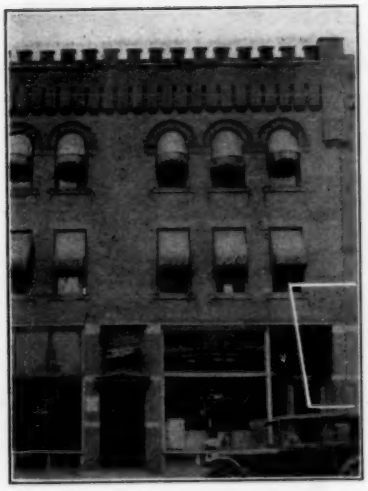

FIG. 8A.

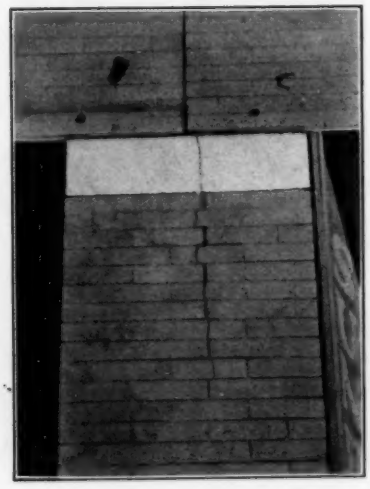

FIG. 8B.

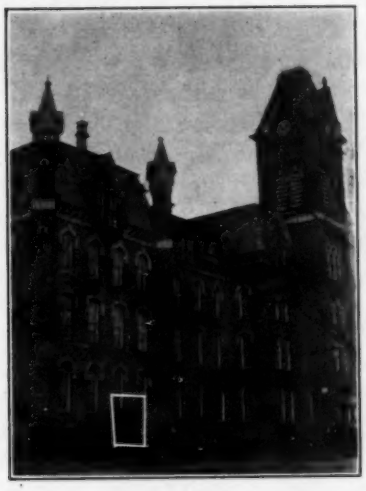

FIG. 9A.

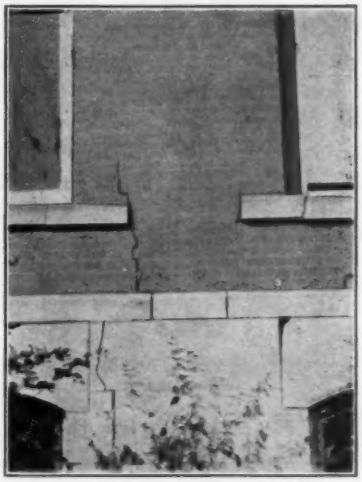

FIG. 9B.

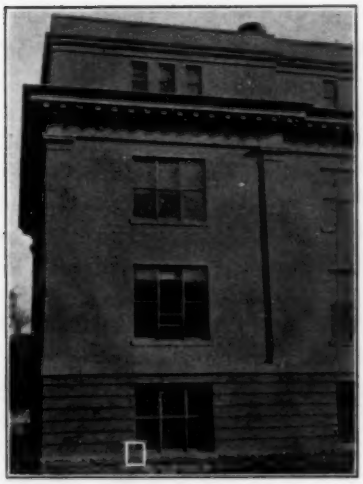

FIG. 10A.

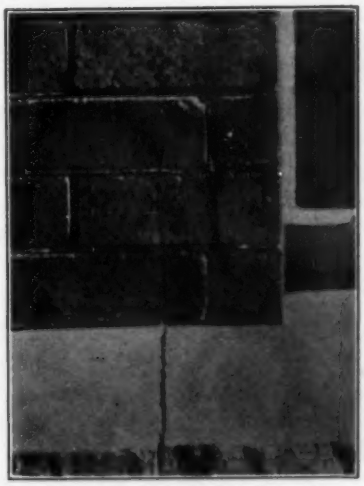

FIG. 10B.

With the exception of Fig. 8, each of these failures occurs either upward or downward, or both ways from the end of a stone sill. In each of the the first four figures, and also in Fig. 9, the cracks are further characterized by connecting with a joint in the stone belt course. In the case of Figs. 5 and 6, the crack extends vertically connecting the ends of the sills and the ends of the lintels of the windows directly below. Figure 8 is a similar type of failure, although the construction conditions are slightly different than in each of the other examples. In this case a masonry pier is capped with stone and supports lintel beams which span wide openings. The crack appears through both the stone capping and downward through the masonry from the meeting plane between the ends of the lintels.

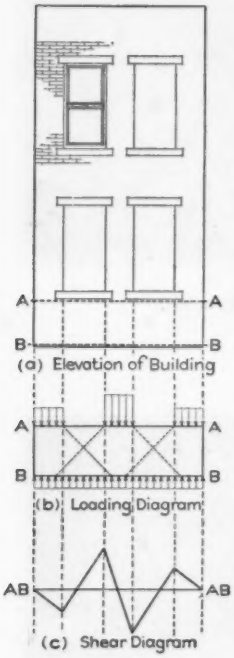

FIG. 11.

Analysis of Failures

It is doubtful if any building exists in which load-bearing masonry walls are uniformly loaded throughout their entire area at any one given horizontal plane. This could be true only of a building without windows or doors, and in which the roof and floor construction was such as to produce uniform and continuous bearing on the masonry.

In normal building design the loads will fluctuate between wide limits throughout any one horizontal plane of the masonry walls. Roof construction is ordinarily supported by trusses or girders which concentrate the load to a small bearing area on the masonry. Floors may be similarly designed and the points of support are aligned vertically from story to story, so that a very appreciable load concentration on the masonry will accumulate at first story level. Doors and windows not only decrease the actual bearing area of the masonry, but the lintels or beams spanning the openings tend to concentrate the load which must be distributed to the remaining masonry, not uniformly, but highly concentrated at the jambs of the openings. Such load concentration becomes an important structural problem when two or more openings are spaced closely together leaving only narrow masonry piers for support.

Load concentration sets up forces which tend to shear the masonry. Figure 11 illustrates a typical building elevation in Part (*a*). Part (*b*) is a diagrammatic representation of the loads imposed from the masonry below the sill level of the first story windows. The weight of this wall, together with roof and floor loads transmitted to it, becomes concentrated

into three restricted areas. The loads on these restricted areas tend to punch into or compress the masonry wall that lies below the sill level. Assuming that the masonry wall is constructed on a substantial foundation, the shear stresses would be diagrammed as in part (*c*) of Fig. 11. The point of maximum shear occurs in line with the jambs of the openings.

These shear forces exist, to some degree, in every masonry structure, and not infrequently the conditions are such that the stresses exceed the shear strength of the masonry, and the result is vertical cracking. The end of a stone sill projecting into the masonry at the point of maximum shear is very apt to produce a crack in the jamb immediately above the sill. Of course the stone sill is itself subjected to an equal amount of shear, but the stone normally possesses greater strength than the masonry; therefore the failure usually occurs in the masonry just above the end of the sill.

In Fig. 9 the sills project into the masonry a considerable distance and consequently the sill is subjected to a large bending moment causing it to crack. A cracked sill frequently results when it is laid in a full bed of strong mortar. A recognized practice is to bed with cement mortar only under the ends of the sill, using plastic caulking cement under the sill except at the ends. Where this practice is observed, cracked sills seldom result because very little bending moment or shear stress can be set up.

The stone sill projecting into the masonry pier produces an effect similar to that of a jetty projecting out from the bank of a river. The jetty produces backwater and usually a direct line of eddy currents and small whirlpools define the edge of the backwater, just as a crack defines the area of resisting stresses in the masonry jamb.

A stone belt course with a joint in the plane of maximum shear does not add to the structural integrity of the wall. In fact, such joints almost invariably define the plane of shear and cracks will lead from them.

Vertical cracks are observed more frequently at the ends of sills than at the ends of lintels. This is reasonable because theoretically more shearing force would be exerted by the projecting end of a sill than by the bearing end of a lintel. At the end of the lintel the masonry is under some compression, due to the weight of the structure above it, and immediately under the lintel bearing the masonry is subjected to an additional compression due to the load reaction of the lintel. Shear is set up because of differential loading. On the other hand, the sill rests on masonry which is immediately below a window opening and thus this masonry is not under compression. The end of the sill, however, projects into the masonry of the pier which is under high compression, and the shear set up in this case results from masonry under high compression adjoining masonry under no compression. This condition naturally produces greater shear than that caused by the differential loading at the lintel bearing.

Computations of the actual amount of shear and compression at these critical points indicate that in typical building design the unit shear at either the end of the sill or lintel is greater than the unit compression at these respective points. As far as brick is concerned, laboratory tests indicate that individual brick resist higher unit loads in compression than in shear. In view of such facts, it is to be expected that vertical shear cracks would be the predominating type of brick masonry failure.

Conclusion

It would appear that laboratory tests on masonry have not been thoroughly coördinated with a study of critical conditions as observed in practice. It is suggested that the scope of laboratory testing be broadened to include a study of shear stresses such as have caused the typical failures illustrated in this paper. The information obtained by loading test walls uniformly over their entire bearing area should be supplemented and qualified by tests in which the walls are loaded upon restricted areas. Shear stresses are always present where one portion of a wall is under higher compression than another. Such tests simulate the critical loading conditions which exist at truss, girder, beam, joist or lintel bearings, or at projecting sills.

From an architectural or structural engineering viewpoint, there is much to be learned from analytical tests, as suggested above, that can be applied to better the design of structural masonry. From the viewpoint of the clay product manufacturer, there is also something to be learned that can be applied to improve the structural properties of masonry units. The prevention of shear failures depends largely upon coördinated effort in manufacture and use.

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EFFECT OF TYPICAL SLAGS ON FIRE BRICK WITH A METHOD OF DETERMINATION CORRELATED TO SERVICE[1]

By Chester E. Grigsby[2]

ABSTRACT

In an investigation of the problem of producing refractories which would give maximum resistance to slags encountered in service, laboratory slag tests were made in a rotary slagging test furnace. A photograph and sketch of the furnace are given and the method of operation is described. A photograph of a typical test is shown and test data are given for typical high iron oxide, high lime, and high soda slags. These data include the numerical rating of ten test bricks in each case. Ten slag tests have been made with 50 different mixes, all in the field of fireclay and diaspore refractories.

Bricks of the brands which give best results in the laboratory were tested in service in malleable iron air furnaces, gray iron cupolas, and "bull" ladles where sodium carbonate purifier is used. Operating conditions are given and chemical analyses of slags presented in several instances. Special firing treatment was given a few bricks prior to service tests.

Excellent correlation between laboratory and service tests was obtained in cases where high-temperature abrasion was not severe, demonstrating the reliability of the rotary furnace type of slagging test in predicting service results insofar as slag alone is concerned.

Of equal importance with the reliability of the slag test is the need of a reliable high-temperature abrasion test. The data indicate that in many installations high-temperature abrasion is the major cause of failures that are charged entirely to slag erosion. Appearance of the brick usually gives little clue as to the destructive agent responsible. The best brick for service in any given installation depends on which destructive force is the greater.

Introduction

One of the most difficult problems which confront the user of fire brick today is the selection of brick which will satisfactorily withstand the slags encountered in service. Perhaps the most common condition encountered in metallurgical furnaces is a slag-covered reservoir of molten metal. In many cases the slag is agitated by a strong blast, as in the reverberatory type of furnace commonly used for the manufacture of malleable cast iron. In other installations the slag forms a comparatively quiet covering over the metal. An example of this type of service condition is the "bull" ladle for cast iron where sodium carbonate purifier is used. Other things being equal, the erosion due to action of slag is most rapid where flow occurs. This is due to continued removal of dissolved material and exposure of the brick to fresh, highly active slag.

Scope of Work

In the investigation of this problem no attempt was made to go deeply into the fundamental reactions which take place between slags and fire

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Illinois, February, 1929. (Refractories Division.) Received December 21, 1928.

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brick in service. The purpose of the work was primarily to develop the most resistant mixture of clays in the least possible time. Use was made of those physical and chemical properties of clays and brick which were known to affect resistance to slag erosion. A rotary, simulated service, slagging test furnace was designed which was similar to the one used by Hursh and Grigsby in their work on boiler-furnace slags.[3] A few changes were made in the furnace to permit use of slags which in service are found covering a reservoir of metal. In addition to standard brick now on the market a large number of special mixes were made and tested. While the tests are not exhaustive, it is believed that the results are not greatly in error in regard to the relative resistance of fire brick to slags of the types tested.

Limits of Slag Tests

It is desired particularly to point out the limits of any slag test in predicting results in many types of installation, *i.e.*, where both slag and abrasion are encountered. Tests have indicated that it is safe to rely on the results of the rotary furnace type of slag test where only slag is encountered in service. It seems probable, however, that slag is often charged with destruction of brickwork which is really destroyed to a large extent by high temperature abrasive action. Very likely the slag indirectly speeds up the destruction caused by abrasion, by the formation with the brick of eutectics of low P.C.E. value, under conditions where abrasive action on an unaltered firebrick lining might be negligible. On the other hand, coal ash, coke dust, etc., carried in a flame of sufficient velocity might conceivably abrade a refractory wall, the surface of which has been rendered soft by the formation of eutectics of brick and slag, to such an extent that the failure of the wall would be much more rapid than if the brick were subjected to slag alone. This would be due to exposure of fresh brick surface to slag caused by removal of a diluted slag coating by abrasion. Slag and abrasion combined, as they are usually encountered in service, may form a condition which is second to none in severity of action on fire brick. It is hoped that a better realization of the need for a hot abrasion test will help to bring forth such a test. No doubt the rotary furnace principle should be employed in this test, as it is in the slag test, to insure identical treatment of all the brick being tested.

Slagging Test Furnace

General Description of Furnace

A photograph of the furnace and auxiliary equipment is shown in Fig. 1. A cylindrical test chamber, supported on and kept centered by casters, is rotated

[3] R. K. Hursh and Chester E. Grigsby, "A Laboratory Furnace for Testing Resistance of Fire Brick to Slag Erosion." Eng. Expt. Sta., Univ. of Ill., Urbana, Ill., *Circular*, No. 17.

about its vertical axis during the test. It is heated to the desired temperature by an oil burner using kerosene and air both at high pressure Slag is introduced through the hole in the crown block and, when melted, floats on a bath of metal which has previously been melted to protect the bottom of the furnace from the action of the slag. The molten mass of slag and metal is agitated violently by the blast from the burner. Slag may be tapped out of the furnace at intervals as desired. Furnace temperature and atmosphere can be closely controlled to simulate the conditions in the type of industrial furnace for which the test is being made.

Furnace Details Details of the furnace are shown in Fig. 2. Twelve test brick, *T*, are set up as shown, but the results on only ten are recorded because the 2-inch brick, *A*, shown on each side of the tap-hole as a protection for the adjacent test brick, are sometimes abnormally eroded by the flow of slag through the tap-hole, and the results on adjacent brick are unreliable. The test brick and special feather edge brick, *F*, are laid up with a thin mortar of first quality fire clay and grog, and are surrounded with $2^1/_2$ inches of Sil-O-Cel brick, *S*, inside the steel jacket, *J*. The top of the chamber is covered with a special semicircular crown block, *C*, which rests just above the test brick.

FIG. 1.

The flat, annular, $^1/_2$-inch steel base plate, *P*, on which the brickwork rests is provided with a 10-inch hole in the center as a provision for the continuous-flow, impingement type of slag test, the hole being covered with a $^1/_4$-inch steel plate to support the bottom brickwork in the bath type tests. Above plate, *P*, a course of 2-inch brick, *Q*, is laid on the flat, covered with two courses of $1^1/_4$-inch split brick, *R* and *U*, the latter being ground so that when laid up properly a depression $1^1/_4$ inches deep by 10 inches in diameter is left in the center of this course. Into this depression is melted a mixture of pig iron and unannealed malleable iron sprue to act as a bath, *K*, on which the slag can float without eroding the bottom.

The furnace is supported by three ball bearing casters, *B*, bolted in place on three reinforced concrete piers, *V*, 120° apart, and kept centered by three ball bearing casters, *W*, which are held in place by the supports, *X*. Wooden wedges, *Y*, driven between the steel jacket and three short angles, *G*, riveted 120° apart to the top of the base plate, prevent any slippage of the chamber relative to the plate. A semisteel cast tooth bevel gear ring, *Z*, bolted to the bottom of the base plate and driven through a

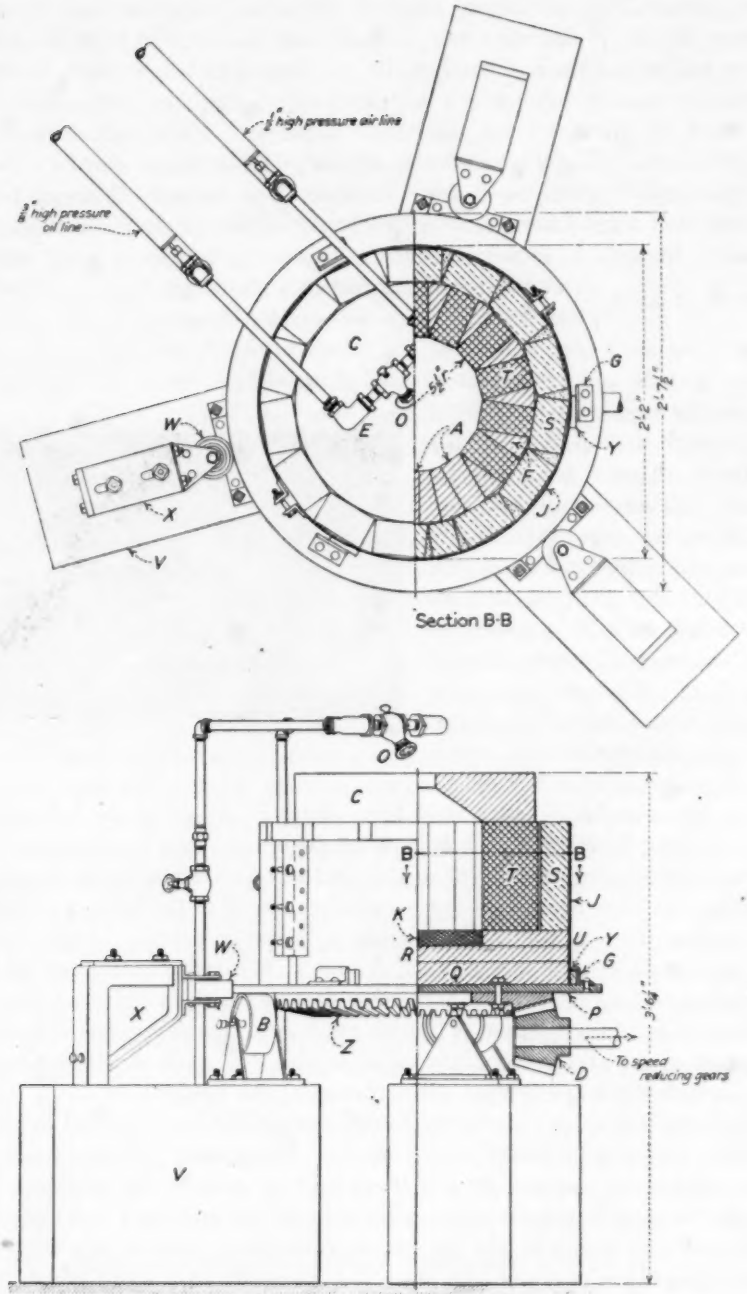
1/8" high pressure air line
1/8" high pressure oil line
C
E
O
A
T
S
F
G
Y
J
W
X
V
2'-2"
2'-7½"
Section B-B
O
C
B
T
S
J
K
R
U
Y
G
Q
P
W
X
B
Z
D
3'6½"
To speed reducing gears
V

FIG. 2.

semisteel cast tooth bevel pinion, *D*, and a set of speed reducing spur gears to a motor, drives the furnace at 13 r.p.m. The furnace is fired with kerosene and air both at 60 to 75 lbs. pressure. The burner, *O*, is equipped with a packed swing joint, *E*, which permits the angle of the burner to be changed at any time.

Method of Furnace Operation

Heating Up It is necessary to leave the tap-hole open until the furnace has attained a yellow heat, as the incoming and outgoing gases must all pass through the 3-inch opening at the top and the burner will not stay lit when the furnace is cold unless the tap-hole is open. A long yellow flame is necessary at first, but as the furnace gets warmer more air can be turned on until finally a blue flame is popping down into the furnace chamber. The chamber then heats very rapidly and after it has attained a yellow heat the furnace may be stopped momentarily, and the tap-hole closed with a "bod" of stiff clay. The burner is very sensitive to the size of the tap-hole which should taper from about $^3/_4$ inch wide at the hot face of the test brick, to $1^1/_4$ inches wide at the cold face of the brick, the height at both faces being about $4^1/_2$ inches. Care in closing the tap-hole will be rewarded when the charge has to be tapped out. The inside of the "bod" burns hard, and if made too thick is very difficult to break through. The proper thickness is about $^1/_2$ to $^3/_4$ inch depending on how often tapping is done. As erosion proceeds inside the chamber, the "bod" of course becomes thinner, and if properly put in will always show red. After the tap-hole has been closed the furnace may be heated as rapidly as possible.

Introducing the Slag The slag, which may be introduced as soon as the casting, *K*, is melted, is usually in the form of 1- to 2-inch lumps. Examples of this material are pieces of malleable furnace slag, limestone, cupola slag, and broken sodium carbonate cakes. If finely divided material such as roll scale and manganese dioxide is used, it cannot be introduced in a slow, gradual stream as the exhaust gases blow the greater part of it away. By quickly dropping the charge into the opening, however, the mass weight of the material above forces the lower portion into the furnace chamber. It is necessary for the operator to wear an asbestos helmet, coat, and gloves as there is a shower of molten slag blown about 10 feet in all directions by the burner. Colored glasses are necessary to protect the eyes from the glare of the furnace.

Tapping the Slag When the furnace chamber has become about half full of slag, so that the burner blows too much of it out, clogging the crown block opening and collecting on the tip of

the burner, the furnace is stopped and the slag is tapped out by driving a sharp, cold chisel through the "bod" in the tap-hole. When the opening has been made and the slag flow started, the furnace is rotated and the slag allowed to spray out. If the opening tends to clog, the furnace is stopped momentarily and the opening renewed by forcing a $^3/_4$-inch iron rod through it. It would be advisable to have the casters and gear bearings protected from this hot slag, as it cakes the grease in the cups.

Removing and Measuring Test Brick

When the test brick have been eroded to approximately one-half their original size as estimated by observation, the furnace is stopped and permitted to cool. The chamber is dismantled, the test brick separated, and the mortar removed. Any depressions caused by uneven breaking of slag at the joint are filled flush with the slagged surface by means of stiff plastic clay. The residual volume, obtained by the water-suspension method, is subtracted from the original volume obtained in the same way before test. The result is the volume eroded. The volume eroded is divided by the original area of the face of the brick exposed to slag. This method corrects for the variation in size of the individual bricks before testing. The brick are then rated according to the volume eroded per unit area exposed (cu. cm. eroded per sq. cm. exposed). The slagged portion is paper-thin in all except highly porous brick and it is possible to give a numerical rating to the test brick on a fairly accurate, quantitative basis. Since the penetrated portion of a brick would still be effective in service and the rating is made on the basis of bulk volume, there is no great error in comparing brick which have some penetration with those which have none.

The description of brick referred to in this paper follows:

Brand or Mix

- A Hand-made diaspore brick, 70–75% alumina
- B Stiff-mud re-pressed, flint fireclay and grog brick
- C Stiff-mud re-pressed, flint fireclay and grog brick
- D Stiff-mud re-pressed, high grade plastic clay brick
- E Dry-press, siliceous fireclay brick, 70–75% silica
- F Flint fireclay brick made by a patented process for carbonizing clay, supposed to produce a brick particularly resistant to high iron slags
- G Hand-made diaspore brick, 70–75% alumina
- H Hand-made flint and plastic fireclay brick
- I First quality, semidry press, flint fireclay brick
- J First quality, stiff-mud re-pressed, flint fireclay brick
- K Hand-made diaspore brick, 60–65% alumina
- L Stiff-mud diaspore brick, 50–55% alumina
- M Stiff-mud re-pressed, high quality plastic fireclay brick
- N Hand-made diaspore brick, 50–55% alumina
- O Stiff-mud re-pressed, flint fireclay and grog cupola block (same mix as "B" brick), P.C.E. 33 to 34
- P Stiff-mud re-pressed, flint and plastic fireclay and grog cupola block, P.C.E. 32+
- Q Stiff-mud re-pressed, high grade plastic clay cupola block, P.C.E. 32
- R Hand-made plastic clay cupola block, P.C.E. 29–30
- S Hand-made plastic clay and grog brick

Tests with Slags Encountered in Service

(1) Malleable Cast-Iron Reverberatory Furnaces

Service Conditions Analyses reported by different investigators indicate relatively wide variations in the amount of ferrous and ferric oxides, oxide of manganese, alkalis, and alkaline earths to be found in malleable iron furnace slags. Some analyses contain as much as 35% ferrous oxide and 5% oxide of manganese. These two oxides form the greater part of the destructive portion of the slag. Silica and alumina, obtained largely from the reaction of the slag with the brick lining, generally form more than 50% of the slag analysis. The temperature above the bath is often 3050 to 3100°F, when the metal is ready for tapping. The service obtained from sidewall brick has been known to vary from 11 to 33 heats in different furnaces both of which use brick of Brand I.

Different sides of the same furnace sometimes give different lengths of service. One wall may give 11 heats and the other 22 heats with the same brand of brick. The erosion on the same side of any given furnace varies widely from week to week. A wall which regularly gave 20 heats with brick of Brand J, gave only 10 heats in one instance. The maximum variation in this particular wall, during a two weeks' period of observation, was from $4^3/_8$-inch minimum wall thickness at the slag line after 20 heats, to $3^3/_8$-inch minimum wall thickness after 10 heats. This difference shows that the lining was eroded 2.45 times faster in the latter case than it was in the former. Since both the service and the brick quality will vary somewhat, if it happens that a poor lot of brick is called upon to withstand extra severe service, disastrous results may follow. It seems reasonable that the severity of service may be subject to greater variation than the quality of a given brand of brick, but foundrymen will not usually agree to this.

FIG. 3.

Slag Tests A total of eight tests with high iron-oxide slag have been made. The test results shown in Fig. 3 have been selected as typical of those made with this type of slag. In this test the furnace was run 8 hours on each of 3 days, or a total of 24 hours. The total time at operating temperature was $19^1/_2$ hours. While it is possible to save time and fuel by completing the test all in one run, the glare of the furnace at night is very blinding to the operator. The maximum temperature during the test was 2775°F, with the minimum 2400°F, and the average 2500°F.

The slag is sufficiently fluid at 2400°F in a reducing flame to be highly active. At hourly intervals 2 kg. of malleable iron furnace slag, 2 kg. of roll scale, and 0.4 kg. of manganese dioxide were introduced into the furnace. The total amount of charge required to produce the results shown in Fig. 3 was 32 kg. of slag, 48 kg. of roll scale, and 6.4 kg. of manganese dioxide.

Ordinarily the slag is tapped out about every four hours. The roll scale was largely magnetic oxide of iron. It was known from previous investigation that a concentration of about 65% iron oxide made a highly active slag. Therefore, the charges were made up in such a way that the percentage of iron oxide was raised to 65, and the other highly active ingredients were increased in the same ratio, so that the proportion of active constituents in the slag used for test remained the same as that found in a typical malleable iron furnace slag. The manganese dioxide was approximately 9% of the charge. The purpose of increasing the active constituents of the slag used in these tests was to approximate the composition of a typical malleable iron furnace slag before it has been diluted by alumina, silica, etc., obtained from the brick in the furnace lining.

The results of the test shown in Fig. 3 follow, the order in the photograph from left to right being the same as that reading down the column.

Brand	Cc. eroded per sq. cm. exposed	Porosity	Rating
A	3.01	31.05%	1
A	3.07	30.90	2
B	5.34	14.90	3
B	5.45	15.35	4
C	5.60	20.05	5
C	5.61	20.35	6
D	6.34	16.15	7
D	6.36	15.30	8
E	8.75	29.50	9
F	9.09	31.70	10

Service Tests Twenty-two service tests have been made in five different furnaces of four companies in two manufacturing districts. In all service tests the brick were alternated in the wall with regular sidewall brick and measurements were made at the joint between adjacent bricks of the two brands. While not absolutely accurate, this method is not much in error when the average of several such sets of brick is taken. A check was obtained on three of the brands in two different furnaces, the good results with Brand G in the 25-ton furnace being checked repeatedly. It is believed that all the tests are fairly reliable, even though the service may have been extra severe in the 12- and 15-ton furnaces just when the high alumina brick were being run, as in the case cited earlier where Brand J brick gave less than half their usual service.

Service Record No. 1 This service record was obtained in a 25-ton, hand-fired, hand-charged furnace using southern Illinois coal, and operated at about 60% of rating with a temperature of 3060°F at tapping time. In this furnace brick of Brand G gave double the service obtained from brick of Brand H, which regularly gave 11 heats with $5^1/_2$-inch maximum erosion in the side walls after a week when service conditions were particularly light, and 9 inches maximum erosion after a week when service was extra severe. Brick of Brand G had been found in previous slag tests to be slightly superior to brick of Brand A in resistance to high iron slag, while brick of Brand H proved to be very close to brick of Brand C in resistance to this slag. It was found that Brand G brick would not withstand the spalling action encountered near the top of the side wall in this furnace. The check between slag and service tests in this furnace was found to be excellent. In slag tests brick of Brand G had been found to be 50% better than brick of Brand H, and in this furnace the service tests indicated that Brand G brick were 57% better than those of Brand H. A chemical analysis of a representative sample of the slag follows:

	(%)	
Silica	51.40	
Alumina	15.95	
Ferrous oxide	22.87	(or 25.43 ferric oxide)
Metallic iron	4.53	
Lime	0.59	
Magnesia	2.48	
Titania	1.87	
	99.69	
P.C.E.	9	

While this furnace was much less severe on brick of Brand G than the 12- or the 15-ton furnaces mentioned later, it was considerably more severe on brick of Brand B than either of the smaller furnaces. It was, therefore, considered probable that the major cause of failure was abrasion in the two smaller furnaces, since they were both operated considerably nearer to rated capacity than the 25-ton furnace. Obstruction of the passage of gases by a fully charged furnace would cause them to whip along the brick lining at high velocity with disastrous results on porous brick such as those of Brand G, which will average about 38.5% porosity. The major cause of failure in the 25-ton furnace, operated at low per cent of rating, would be expected to be slag action on account of its low velocity of gases and high percentage of corrosive agents as shown by the analysis of the slag. Thus the brick of Brand B would not be expected to give as good service in this furnace as those of Brand G or as good service as they do in the 12- or 15-ton furnaces.

The increased time required to melt the higher tonnage probably more

than offsets, as far as brick of Brand B are concerned, the advantage of the 25-ton furnace in having a somewhat less corrosive slag and less abrasion than the 12- and 15-ton furnaces, while the severe abrasion of the smaller furnaces offsets, with regard to brick of Brand G, the advantage of less time under fire per heat.

Service Record No. 2 In a 20-ton, hand-fired, crane-charged furnace, using West Virginia splint coal and operated at 85 to 90% of rating, brick of Brand B were found to be 4.8% better than brick of Brand M which regularly gave 22 heats with 5 inches maximum erosion after two weeks of light service, and $7^1/_2$ inches maximum erosion after two weeks during which the service was extra severe. The Brand M brick show an average of about 18% porosity and a P.C.E. of 32. The service data given above are a fairly good check on the 8.5% that the slag test had indicated as the amount by which Brand B brick excelled those of Brand M. With brick not exceeding 25% porosity a good check has been found between slag and service tests. This is because the severe effect of abrasion is not noticed except on brick which have a porosity above this amount.

Service Record No. 3 This record, obtained in a hand-fired, crane-charged furnace of 15 tons capacity, tapping at 3050°F, and operated at 85 to 90% of rating with West Virginia splint coal, showed that brick of Brand J, which regularly gave 22 heats with $5^1/_2$ inches maximum erosion after two weeks when service was not severe, to $8^1/_2$ inches after two weeks when service was particularly severe, were 67% better than brick of Brand K. Brand J brick will average about 18% porosity and 33 to 34 P.C.E. Slag tests had shown them to be approximately equal to brick of Brand B in resistance to high iron slag, and service tests indicated that the slag test data were correct. Brick of Brand J were also found to be 73% better than brick of Brand L, which have an average porosity of about 28%. The failure of brick of Brands K and L in this furnace, in spite of the fact that brick of both these brands had been shown in the slag test to be superior to those of either Brand B or J, was attributed to their high porosity which rendered them unfit to withstand the abrasion in this furnace which was operated at almost rated capacity. A representative sample of slag from this furnace showed the following analysis:

	(%)
Silica	60.22
Alumina	8.96
Ferrous oxide	27.51
Lime	0.74
Metallic iron	1.87
Titania	0.94
	100.24

Service Record No. 4 In a twelve-ton hand-fired, hand-charged furnace using West Virginia splint coal and operated at 85 to 90% rating and 3056°F, bricks of Brand I which regularly gave 11 heats with $3^1/_2$ inches as the maximum amount of brick eroded after a week of light service, and $6^1/_2$ inches maximum erosion after a particularly severe run of one week, were found to be 8% better than brick of Brand G. This result again demonstrated that brick of such high porosity as those of Brands G, L, and K, are entirely unsuited to withstand the abrasion in a malleable iron furnace operated near its rated capacity. Brand I brick will average about 16.25% porosity and 30 to 31 P.C.E. Slag tests gave brick of Brand B a rating 8% better than those of Brand I, while service tests in this furnace rate brick of Brand B as 15% better than those of Brand I.

Specially Treated Brick In order to determine the effect of decreased porosity and high firing temperature, two special tests were run. The first test, run in a side wall of the 15-ton furnace described in Service Record No. 3, made use of brick which had been subjected to load conditions shown below These specially treated brick were compared to brick of Brands J and G, which had been subjected to only the regular kiln firing.

Brand	Sample	Subjected to load shown at 2714°F for 7 hours (cone 18 down)	Deformation under load (%)	Porosity (%)	Per cent by which brick excel brick of Brand J
G	1	25 lbs./sq. in.	19.03	26.0	4.5
G	2	8 lbs./sq. in.	11.50	31.2	0.0
G	3	(Regular cone 14 firing, no load)		39.0	−2.0
K		" " " " " "		35.0	−5.0

The results indicate a progressive increase in resistance to slag and abrasion with brick of Brand G as the porosity is decreased. Too much significance cannot be attached to the results because of the limited number of samples. There is no doubt that the three bricks of Brand G used in this test were at a disadvantage by being surrounded in the wall by brick of Brand J which eroded more rapidly leaving the specially high fired G brick protruding into the furnace so that they were abnormally exposed. Had they been surrounded by brick of equal quality they would no doubt have shown up to better advantage. No further work was done along this line as the results have only an academic interest. It is entirely unlikely that such specially treated brick would be of enough better quality to make them economical, as any process for the manufacture of very dense brick of 70 to 75% alumina content would add a great deal to their cost. The brick, moreover, would very likely spall more readily than brick of normal structure. The spalling of the regular fired high alumina brick tested eliminates them from use near the top of side walls in many malleable furnaces.

Another interesting experiment in the effect of high firing, as affecting resistance to slag and abrasion, was made in the 12-ton furnace already referred to in Service Record No. 4. Some brick of Brand B, which are normally fired to cones 10 to 11, were refired to cones 20 to 26. The brick which had been subjected to the high firing were alternated in the same course in the side wall with brick of the same mix which had received only an ordinary firing treatment. The hard-fired brick were no better after eleven heats than those of ordinary firing. Inspection of the brick structure readily revealed the reason for this. The structure and color of the brick of the special firing and those of the regular firing were identical fully one-half inch from the fire face. Beyond this point, the brick which had received only a normal firing showed evidence of a gradual lowering of firing temperature, until the structure well away from the fire face became the same as that resulting from the kiln fire. A simple calculation will show that no other result could be expected. If a temperature of 400°F is assumed at the cool end of the 9-inch brick lining and 3100°F taken as the temperature of the fire face, it is found, by use of a straight line temperature gradient, that when the wall is 9 inches thick the theoretical cone 26 temperature would exist more than $^1/_2$ inch from the fire face. As the wall gets thinner the temperature gradient may become somewhat sharper, but the appearance of the brick structure indicates that, in effect, at least a cone 26 firing is at all times taking place about $^1/_2$ inch ahead of the erosion. Very likely brick in service are thus prepared to resist erosion and abrasion just as well as if they were fired to cone 26 in the kiln. Doubtless a similar firing takes place ahead of the destructive action imposed by service in a great many types of furnaces. If the brick are to be fired in service as effectively as they can be fired in the kiln then, with the possible exception of installations where shrinkage, or spalling due to shrinkage, is a cause of failure, extremely high firings would seem to be a waste of money.

In the furnaces studied no definite relation was found between method of charging, size of furnace, coal used, etc., and service received from sidewall brick. This may have been due to the fact that no great effort was made to find such a relation, as it was of course necessary to meet conditions as they exist.

Flint fireclay, stiff-mud re-pressed brick of Brand B have now been used with success in all these furnaces as well as several others, the conditions of which are not known.

Summary of Malleable Furnace Tests

In summing up the results of tests which pertain to this type of furnace, use is made of data which to a large extent are given in this paper. Some of the test results, however, obtained in the pursuit of this work, but not given here, are also utilized.

(1) There was excellent correlation between laboratory slag tests of the rotary furnace type and service tests with all brick under about 25% porosity. For brick of approximately 25% porosity, or greater, the correlation was excellent when slag was the major cause of failure in service.

(2) The high alumina brick showed excellent resistance to high iron slags, their resistance increasing with increase in alumina content, in spite of the fact that the porosity also increased. Their resistance to high temperature abrasion and thermal spalling was poor, and generally decreased with increasing alumina content.

(3) Composition was more important than physical structure in determining resistance to this slag.

(4) Other things being equal, increase in porosity generally decreased resistance to slags and high temperature abrasion, though individual brick of some mixes showed reversals of this, due to the fact that porosity alone gives no indication of size of the pores.

(5) The dry-pressed siliceous fireclay brick (70 to 75% silica) were eroded very rapidly by the high iron slags.

(6) Flint fireclay brick made by a carbonizing process were reputed to possess high resistance to high iron slags, in spite of the fact that they were made by the dry-press process and were highly porous. The tests indicated that such brick possess far less resistance to this type of slag than untreated brick made of the same clays.

(7) Increase of grog decreased the resistance of flint fireclay brick to high iron slags and also reduced resistance to abrasion.

(8) Firing flint fireclay brick as high as cone 26 did not increase life in malleable iron air furnace side walls, under conditions where both slag and high temperature abrasive action were severe.

(9) Increase in plastic clay content decreased resistance of the bricks tested to high iron slag and high temperature abrasion.

(10) Flint fireclay and grog brick of 12 to 20% porosity, 33 to 34 P.C.E., silica 45 to 50%, and alumina 40 to 45% made by the stiff-mud re-press method, showed best results in both laboratory tests and service tests in side walls of malleable iron air furnaces.

(2) Gray Iron Cupolas

Service Conditions The life of cupola linings where lime is used as a flux is generally more severe than where no flux is used. The percentage of lime in the slag where trouble is encountered in cupola linings has been found to vary from 9.23% in one case to 39.04% in another. Abrasion is also very rapid due to the action of coke particles at high velocity. Temperatures usually range from 2600 to 3000°F in the hot zone and conditions are often reducing. The slag and abrasion

combined make the service so severe for fire brick that a great many cupolas require daily patching in the hot zone.

In a 10-ton Newton cupola from which slag was obtained for the high lime slag test, the erosion and abrasion amounted to as much as 4 to 5 inches per day in the hot zone. The blocks in use were 9- by 6- by 4-inch hand-made blocks of a coarse grind, with a porosity of 26.6%, and a P.C.E. of 29 to 30. The maximum temperature in the hot zone was given as 2600°F, the atmosphere generally reducing. No sodium carbonate was used.

The slag was very glassy, dark green to black in color, and had a P.C.E. below 3 or below 2172°F. The following chemical analysis of the slag was obtained:

SiO_2	46.27
Al_2O_3	19.90
Fe_2O_3	1.93
Titania	1.24
CaO	28.59
MgO	0.63
	98.56

This analysis indicates that the slag action was due largely to the lime used as a flux. The ferric oxide, magnesia, etc., are too small in amount to be so highly corrosive. The percentage of limestone used in cupolas as a flux varies from 0.0 to 5.0% or more, usually about 3% being used. While this is a small percentage of the total charge, it is practically all concentrated in the slag. By subtracting from the above analysis alumina and silica in the kaolinite ratio, and recalculating the remaining constituents to 100%, the lime becomes approximately 50%. This should be the approximate percentage of lime in the slag before reaction with the brick lining if we assume that silica and alumina in the clay ratio, and nothing else, come from the brick lining and from dirt on the metal charged.

The Slag Test The charge used during the early stages of this test was composed of equal parts of slag collected from the first tap of the cupola each day (see analysis) and limestone which contains about 97% of calcium carbonate. This made the lime concentration in the slag about 54%. Difficulty in melting this charge at the operating temperature of 2680°F led to reduction of the amount of limestone in later charges to such an extent that the lime concentration averaged 37.7% for all charges introduced into the furnace during the first day. The furnace was run with charges composed of all cupola slag during the second day giving a charge of 28.6% lime concentration. Due to relatively little action in two days of testing, limestone was added again on the third day. Smaller charges were used at more frequent in-

tervals which made melting easier and the proportion of limestone was gradually increased on each successive charge until nothing but limestone was used in the last charges. The data show that the average concentration of CaO for all charges introduced during the test was 87.5%. The time required for the test was 32 hours and the time at operating temperature was 26 hours. The maximum temperature was 2810°F and the minimum operating temperature 2600°F.

The slag was very viscous even at 2700°F and did not flow readily from the tap-hole. The time between tapping varied from 4 to $8^1/_2$ hours. The whole third day was run with only one tap at the finish of the test. The results of the test follow, the amount of erosion ranging from $2^3/_8$ to $2^3/_4$ inches.

Brand	Cc. eroded per sq. cm. exposed	Porosity (%)	Rating
O	4.18	14.7	1
G	4.23	38.1	2
K	4.72	37.6	3
P	4.87	13.4	4
L	4.99	28.1	5
Q	5.02	14.6	6
N	5.43	29.5	7
R	6.12	26.6	8

Insofar as slag alone is concerned, dense, all-flint blocks would be chosen for cupola linings. A 70 to 75% alumina brick is a close second and a medium alumina content brick is third. From experience with high alumina brick in service where high temperature abrasion is severe, however, the all-flint blocks would be expected to give best service. In the case of the cupola blocks it is interesting to note that the resistance to slag decreases with increase in porosity and with decrease in P.C.E. value.

Service Records of Cupola Blocks

Only a few of these particular mixes have been tested in service and not a great many service tests have been made in cupolas since running the tests, yet it is interesting to note some service data available from our records and service calls. Some of these service records are rather conflicting. A great deal of this variable service is attributed to differences in amount of abrasion.

Service Record No. 1

Cupola blocks of 50 to 55% Al_2O_3 content were in the hot zone of a cupola three months, during which time 1900 tons of metal were melted. Standard fireclay blocks in two other cupolas at the same plant gave 1350 tons and 1135 tons, respectively, or an average of 1242.5 tons. The high alumina blocks gave an increase in tons of metal melted of 53%. Assuming that the service in all three cupolas was of equal severity and that high temperature abrasion was not a factor, this is a very good check on our slag

test results which show high alumina blocks to be 47% better than fireclay blocks of brand R.

Service Record No. 2 Cupola blocks of 50 to 55% alumina content, but of a mix containing a small amount of grog, were in the lining of a Whiting cupola nearly three months. During that time they were subjected to only 15 different heats bringing down a total of 187 tons of metal. This service was far from satisfactory, as ordinary fireclay blocks regularly gave about 50% more than this amount of service. The foundry superintendent felt that the test was made under circumstances and conditions which would absolutely prove that these high alumina blocks were not suitable for the service, and certainly not at a substantial increase in price. The addition of the grog may have been a contributing cause of this failure but the grog percentage was the same as is used in many standard fireclay cupola block mixes.

Service Record No. 3 In this cupola special 9- by $5^1/_2$- by 4-inch high alumina cupola blocks were eroded 5 inches in four heats, leaving a wall thickness of $^1/_2$ inch on the inner lining. This record is to be compared to 3 months' service from ordinary fireclay blocks with daily patching. The most severe erosion occurred during the second heat after which time the action slowed down somewhat. The blocks had a P.C.E. of 34+ and a porosity of 35%.

The cupola was a 60-inch No. 5 Whiting making gray iron and semisteel castings. The temperature was not known but was estimated by the foundry superintendent as 2200 to 2600°F, depending on whether gray iron or semisteel castings were being made. A flux of 1% limestone was added for either type of metal. The blast pressure was 8 to 10 oz. Care was taken to shut off the blast after withdrawing the last of the metal to avoid the severe action of the direct blast on the lining. Anderson[4] claims that more fire brick are destroyed at this time than would ordinarily be destroyed in two heats. The claim was made that operating conditions on this lining were identical with regular practice. The eroded portion of the lining was a band 28 to 32 inches in height which indicates poor practice according to Anderson,[4] who gives the proper height of the melting zone as about 4 inches above the tuyères. Other authorities give this zone as 8 to 12 inches above the tuyères. The cause of such a wide, high-melting zone is generally attributed by most writers to melting on an air pressure instead of an air-volume basis. The slag from this cupola was very black and glassy with a P.C.E. of 2 to 3.

Service Record No. 4 In another cupola, high alumina blocks of P.C.E. 34+ and 33.6% porosity gave considerably shorter life than is regularly obtained with ordinary fireclay

[4] J. H. Anderson, "Cupola Operation," *Foundry*, p. 770, Sept. 15, 1928.

blocks. No accurate figures could be obtained on the relative life of the two linings. The temperature in the hot zone was 2800°F and no flux was used. The cupola was run with all possible blast on the fan but with insufficient tuyère area. The result was that the eroded portion of the lining was about 30 inches wide starting 6 inches above the tuyères. A cone 11 surface soil was being mixed with a little river sand as a hot zone patch. This patching material melted and flowed at the operating temperature, giving an excessive amount of slag which the foundry superintendent had realized was above normal, but had been unable to explain.

Service Record No. 5 A cupola having 4 to 5 inches of erosion per day had a slag very much like cinders in appearance. It was not glassy and was full of globules of iron. The operating temperature was reported as 2860°F. No other data are available in this record and the analysis of the slag is given as a matter of possible interest.

SiO_2	41.13
Al_2O_3	21.15
Fe_2O_3	0.97
TiO_2	1.38
CaO	12.97
MgO	0.76
Metallic iron	18.87
	97.23

Service Record No. 6 In a 60-inch O. D. Newton Cupola and a 63-inch O. D. No. 5 Whiting, both lined down to 45 inches, at the plant from which the slag for the slag test was obtained, 2 to 3 days' service was being obtained with cupola block of Brand P, with daily patching in the hot zone, about a year after the slag test was run. The blocks showed about $2^1/_2$ inches erosion after one day's service, in a zone extending from about 6 inches above the tuyères to a point 26 inches above them. This hot zone was patched out flush with the rest of the cupola lining each day with Pennsylvania mica schist, which had a P.C.E. of 30 and a porosity of 11.3%. After the second day this patch and about one inch more of the cupola blocks were gone. At the end of the third day the second patch and another inch of block were eroded away, leaving only $1^1/_2$ inches of inner lining. It was necessary to replace the blocks in the hot zone every three days as there was only a thin course of backing-up brick. The superintendent and the cupola operator disagree on the relative merits of mica schist and fire brick as a hot zone patch, but it is likely that with its low P.C.E. value and only fairly low porosity, the mica schist would be inferior to dense No. 1 fire brick. All charges above the bed were, for the Whiting cupola, 35 lbs. limestone (2.83% of charge), 200 lbs. coke and 1000 lbs. pig iron, with the exception that no coke was added to the last charge. The charge for the Newton

cupola was the same except that the iron charge was composed of about 50% pig and 50% gates and sprue. A normal day's run for each cupola was 16 to 17 tons of metal in $3^1/_2$ hours. The product of the cupolas was very small castings, so that the iron had to be hot and the blast left on until all the metal was tapped out. The blast pressure usually was from 8 to 10 oz. on the small cupola and 8 to 11 oz. on the large one, both with an air volume of 3500 to 4000 cu. ft./min. The metal was tapped at 2550 to 2750°F. On one occasion when an extra long run was made, bringing down 24 tons of metal, the blocks of Brand P were eroded $5^1/_2$ inches, leaving only $^1/_2$ inch inside lining after one day of service.

Various tests were tried by the foundry superintendent, with no flux at all and with different fluxes, such as sodium carbonate, and 1 to 2 mixtures of fluorspar and limestone, in an effort to increase the life of the lining. The blast was varied from 500 cu. ft./min. to 5000 cu. ft./min. with the result that cold iron was obtained in the first case and over oxidized iron in the second. The superintendent reported that he could detect no difference in severity of service on the lining with all these changes. Brick of Brand G were found to be no better than blocks of Brand P. Both were superior to those of Brand R. Blocks of Brand O will be tried in the near future. If these do not give increased service it seems safe to say that these cupolas will always give unsatisfactory service from blocks unless the service conditions are altered.

Samples of slag obtained from the Whiting cupola at 2 P.M., the first tap, and 4 P.M., about $^1/_2$ hour before the bottom was dropped, showed the following analyses. The metal on this particular day was tapped at 2560 to 2630°F.

	2 P.M. tap	4 P.M. tap
SiO_2	45.20%	41.64%
Al_2O_3	17.44	15.25
Fe_2O_3	1.05	1.05
TiO_2	1.13	1.22
CaO	33.12	39.04
MgO	0.48	0.51
K_2O }	0.58	0.61
Na_2O }		
	99.00	99.32
	P.C.E. 2	P.C.E. 1 to 2

Service Record No. 7

In another No. 5 Whiting cupola using 1500- to 2000-lb. charges of either gray iron or semisteel, 75 lbs. of limestone were used in each charge above the bed, giving limestone concentrations ranging from 2.81 to 3.85% of the charge; 450 and 375 lbs. of coke were used with 1500-lb. charges of semisteel and gray iron, respectively, and 500 and 450 lbs. of coke with 2000-lb. charges of semisteel or gray iron. The blast pressure varied from 10.5 to 12 oz. Blocks of Brand P gave 4 to 6 months' service in the hot zone of this cupola with patching every 2 to 3 days of a zone extending

from 6 inches above the top of the tuyères to a height of 30 inches above them. The P.C.E. and chemical analysis of the slag from this cupola are:

P.C.E.	5 to 6
SiO_2	48.65%
Al_2O_3	28.82
Fe_2O_3	3.83 (or 3.15 FeO)
TiO_2	1.87
CaO	9.23
MgO	3.75
Metallic iron	1.38
	97.53

Since this analysis is so much lower in CaO content than those given in Service Record No. 6, while the percentage of limestone for the cupola is given as higher, it is believed that the latter analysis is not representative of the slag from this cupola.

A summary of the slag and service data from cupolas is given below.

Summary of Cupola Tests

(1) A good check was obtained on slag test results in cases where abrasion was not serious (see Service Record No. 1).

(2) The high alumina brick of 70 to 75% alumina content were slightly inferior to dense flint-fireclay brick in resistance to high lime slags.

(3) The high alumina brick did not give satisfactory service in the hot zone of most cupolas as abrasion was too severe.

(4) Increase of flint clay and decrease in porosity increased the resistance of fireclay brick to high lime slags.

(5) Stiff-mud re-pressed blocks of dense structure and high flint-fireclay content, as Brand O, will probably give the best service of the blocks tested in cupolas where hot and cold abrasion and slag are severe.

(3) "Bull" Ladles for Cast Iron

Service Conditions

During the last few years the use of sodium carbonate has spread rapidly into many metallurgical operations, particularly the cast-iron foundries. Its use is increasing steadily as specifications on sulphur become more and more rigid each year. The purifier most used, perhaps, is fused soda ash, usually cast into small cakes for convenient handling. It may be added to the charge in the cupola, in the tapping spout, or in the "bull ladle." The life of brick in a ladle lining usually decreases steadily with increase of sodium carbonate.

In a certain foundry, six weeks' service was regularly obtained from ladle linings when no purifier was used. When sodium carbonate was first used 24 lbs. were added to an 8-ton "bull ladle," a concentration of about 0.15% of the charge. The life of the lining was immediately decreased to 2 weeks. Later 32 lbs. or about 0.2% was added to the same

ladle, with the result that the life of the ladle lining was cut to one week. In some cases a few more days could have been obtained but this was of no value as the lining was repaired only on Sunday. The brick themselves were not attacked as much as was the mortar which washed out, along with some of the brickwork, all the way to the back of the lining to such an extent that the brick fell out into the ladle. An excellent article has been written on the subject of sodium carbonate by Evans.[5] Our slag and service tests check some of Evans' conclusions.

High Soda Slag Test

Since practically all of the soda added to this ladle was concentrated in a 3- to 4-inch covering on a 48-inch diameter ladle the concentration of the soda ash in the slag was about 5.7%. For the purpose of increasing the severity of the laboratory test, the 5.7% soda ash was multiplied by the ratio which had been used to increase the iron oxide percentage in the high iron slag tests; 13.0% was thus found to be the desired sodium carbonate concentration. Some of the slag collected from the ladle was used in the slag test, together with fused soda ash cakes. The test was run 9 hours a day on four different days or a total of 36 hours. The furnace was charged once an hour with slag from the ladle and soda ash in such proportions as to give a soda ash concentration of 13% during the first day. Due to little action on the brick during the first day the concentration of the soda ash was increased to 25% during the first half of the second day and to 75% during the remainder of the test. The amount charged per hour was 4.47 kg. during the latter part of the run. This charge was composed of 1.185 kg. of slag and 3.285 kg. of soda ash. The temperature averaged about 2600°F, this being the temperature encountered in service in the ladle.

The results of the test follow:

Brand	Cc. eroded per sq. cm. exposed		Porosity	Individual rating	Brand rating
B	3.01	3.28	14.4	1	1
B	3.55		15.0	3	
G	3.02	3.31	39.2	2	2
G	3.60		38.5	4	
L	3.89	3.92	23.4	6	3
L	3.95		23.7	7	
K	3.67	4.22	37.3	5	4
K	4.77		31.1	9	
S	4.83	4.57	Approx. 22%	10	5
S	4.31		22%	8	

Service Tests

In service all brick showed peculiar cracks which were not, apparently, the result of spalling. The soda ash quickly attacks all laminations and cracks in a brick and peels off pieces of brick as if by expansion on cooling. Brand B brick showed less

[5] G. S. Evans, "Sodium Carbonate Compounds Affect Refractory Linings," *Foundry*, Aug. 15, 1927.

erosion than any brick tested, which checked the slag test results. They did, however, crack off badly due to laminations.

A chrome mortar was used in laying a small patch of brick on the theory that, being neutral, it should resist the basic slag. It washed out of the joints as readily as fire clay, probably on account of its refractoriness which would keep it from firing dense at 2600°F. It appeared to be washed out by mechanical rather than chemical action.

The analysis of this mortar follows:

SiO_2	12.51
Al_2O_3	21.58
Fe_2O_3	7.83
TiO_2	1.04
Cr_2O_3	40.72
KNaO	3.65
	97.33

Although brick of Brand B showed less erosion than those of Brand S, they were not enough better to give another week of service. First quality dry-pressed brick of 12 to 15% porosity also gave as good service as brick of Brand S. Apparently first quality brick possess no appreciable advantage over those of second quality, so that a second quality, dry-press brick of 12 to 15% porosity would seem to be most economical for both the manufacturer and the consumer for ladles where sodium carbonate purifier is used.

Summary of Ladle Tests

(1) The brick of 70 to 75% alumina content gave slightly less resistance to sodium carbonate than dense flint-fireclay brick which gave best results in both slag and service tests.

(2) The chrome ore cement was not materially better than fireclay mortar for this service.

(3) It appears from these tests that a second grade, dense, dry-press fireclay brick of 12 to 15% porosity should give as good service as any brick in these ladles.

(4) It seems that foundries cannot expect more than about a week's service on ladle linings where soda ash of about 0.2% of the charge is used at temperatures in the neighborhood of 2600°F.

General Summary

(1) The rotary simulated service slag test furnace gives results which make it possible to predict accurately which brick, of a number of mixes tested, will give best results in service in cases where slag is the major cause of failure.

(2) For resistance to high iron oxide slag alone, brick of 50% alumina content or over were superior to stiff-mud re-pressed flint fireclay and grog

brick of low (12 to 20%) porosity. For high lime and high soda slags the flint fireclay brick of the properties given above were superior to even the 70 to 75% alumina diaspore brick.

(3) With none of these slags were the high alumina brick tested sufficiently superior to high grade, dense flint fireclay brick to make them economical, except, perhaps, as a belt or patch exposed to a particularly severe slagging condition in installations where high iron oxide slag is the principal cause of failure.

(4) The high alumina brick were inferior to fireclay brick in installations where slag and high temperature abrasion were combined and the latter was relatively severe.

(5) It is considered impractical to reduce the porosity of high alumina brick to a point which will give good resistance to abrasion, without exaggerating their excessive spalling tendencies.

(6) Increase in either plastic clay or grog content was found to decrease resistance of brick to all three types of slag and to high temperature abrasion in service.

(7) Substitution of one first quality plastic fire clay for another in percentages up to 30 was found to produce no change in quality of brick which was of sufficient magnitude to be of practical importance.

(8) High firing temperatures above a point which is necessary to remove the greater part of the firing shrinkage of the brick was found to be a waste of money in cases where high iron oxide slag and high temperature abrasion were the major causes of failure in service.

(9) A mixture of flint fireclay and grog (called O in cupola block size and B in brick size) has been found to be the most economical brick developed during this investigation for service in which high iron slag is encountered with or without high temperature abrasion. This brick is as dense as it was found possible to manufacture a brick economically by the stiff-mud re-press process, *i.e.*, 12 to 16% porosity, and has a P.C.E. of 33 to 34. It has the maximum alumina content and minimum silica content which are consistent with its high fusion and low porosity. Indications are that it will also prove most economical for cupola linings. A dense, second grade dry-press brick of 12 to 15% porosity should prove most economical in "bull" ladles where sodium carbonate purifier is used.

(10) In general, if a brick does not exceed 20 to 22% porosity and withstands a given slag successfully it is thought no fear need be held as to its resistance to high temperature abrasion, as it has been found that brick of low porosity which withstand slags successfully in the slag test give satisfactory service in resistance to slag and high temperature abrasion.

(11) Until a satisfactory high temperature abrasion test has been developed, it would seem advisable to use only brick of low porosity and high P.C.E. value where slag and high temperature abrasion are to be

encountered. Service tests appear to be, at present, the most reliable means of getting accurate information on the relative merits of different brick for installations where slag and high temperature abrasion are to be encountered. With a satisfactory high temperature abrasion test furnace it should be possible to get slag and abrasion data which would, after evaluating the relative severity of slag and high temperature abrasion in service, permit the selection of a brick whose properties would be such as to give maximum possible service under any particular set of service conditions.

(12) Generally speaking, it appears that composition is more important in determining resistance to slags than are physical properties, while with abrasion the reverse seems to be true. To get maximum resistance to either slag or high temperature abrasion requires proper combination of physical and chemical properties.

(13) The excellent check obtained between slag and service tests, in those malleable furnaces where slag was the major cause of failure, seems to invalidate the objection, which has been made, that these high iron slag tests may not be reliable because they were run at temperatures considerably lower than those encountered in malleable iron furnaces. It was thought that the principal effect of high temperature would be to accelerate the action of slag on all bricks, and that the relative resistance of the brick would not be greatly different at the testing and the service temperatures. Results show that for all practical purposes this theory is correct. These tests checked just as well with service as did the cupola and ladle tests which were run at, or near, service temperatures. For more accurate research work any desired temperature may, of course, be reached in order to duplicate exactly the service temperatures by providing adequate compressor or burner equipment.

Acknowledgment The author desires to express his appreciation to B. W. Willson and P. C. McCollom for their coöperation and interest in this work, and to acknowledge his indebtedness particularly to H. B. Stone, who has been of invaluable assistance in the preparation of this paper.

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ORGANIC AGENTS AS AIDS TO THE ADHESION AND SUSPENSION OF GLAZES[1]

By E. S. Foster

ABSTRACT

One phase of glaze preparation and application that has received very little description deals with the use of organic adhesive and suspensive agents. This paper describes the kinds, sources, and uses of the principal organic agents. In addition, shop practice with reference to terra cotta glazes is described. To supplement these descriptions curves are given showing the comparative effects of organic agents on the bonding strengths of a ball clay-silica mixture.

Introduction

One phase of glaze preparation and application that has had meager description in the past, deals with the use of organic adhesive and suspensive agents, or "thickeners," as they are sometimes called. These organic agents are quite important, not only in aiding suspension and promoting the adhesion of the glaze to the ware, but in certain types of glazes, in preventing parting or crawling.

Although this paper deals chiefly with the use of organic adhesive agents in the Bristol type of glaze, as used for architectural terra cotta, it applies equally well to other types of glazes in which these organic agents are used. Shop practice and experience and short descriptions of several organic bonding agents are presented here. In addition, comparative data have been submitted on the bonding strengths of several organic substances.

Adhesive and Suspensive Agents

In practice, the amount and kind of organic adhesive and suspensive agent added to any glaze is influenced by many factors, such as (1) type of glaze used, (2) amount and kind of clay and other materials used in compounding the glaze, (3) method of applying the glaze, and (4) the shop practice. For instance, the use of 10 to 15% of tough ball clay in the glaze will generally give good adhesion to the ware, and the presence of zinc oxide or light magnesium carbonate, even in small quantities, will aid admirably the suspension of the glaze materials. Unfortunately, it is not possible to use ball clay, zinc oxide, or magnesium carbonate in all types of glazes. The use of acids and soluble salts is not always desirable in promoting suspension and is of little value in aiding the adhesion of the glaze to the ware. Consequently, the addition of organic agents, or "thickeners," such as gums, starches, and glues is quite common practice and is generally the most satisfactory method of aiding the suspension of the glaze constituents and the adhesion of the glaze to the ware.

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Terra Cotta Division.) Received November 12, 1928.

A number of different thickeners have been suggested and tried from time to time such as glucose, molasses, sour milk, blood, starch, gum arabic, gum tragacanth, and dextrine. Of this number the last three have probably been found to be most generally satisfactory.

Shop Practice

In our own shop practice gum arabic, dextrine, and gum karaya (a substitute for gum tragacanth) have been used. For use in glazes that do not have a marked tendency to settle out, gum arabic is quite satisfactory. In glazes that contain borax, but do not tend to settle out dextrine is used. Lastly, for thickening, or for use in glazes showing an inclination to settle out, gum karaya serves very well.

Moduli Rupture

Measurements of the dry transverse strength of a clay-silica mixture, with and without the addition of various amounts of organic bonding agents should give a good comparison of the strengths and perhaps of the adhesive properties of these organic materials as used in glazes. Unfortunately, no satisfactory method was evolved for comparing the effects of these various organic materials on glaze flotation. Figure 1 shows dry modulus of rupture plotted against per cent of organic bonding agent added to a mixture of 50% English ball clay and 50% fine-ground silica. It was practically impossible to add more than 2% of gum tragacanth to the ball clay-silica mixture, so the curves for gum tragacanth and gum karaya were only plotted to 2%.

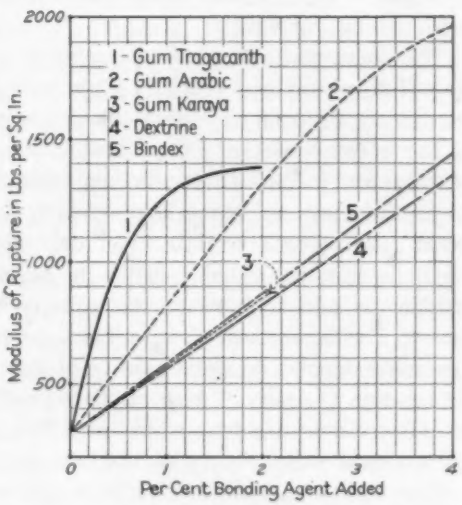

FIG. 1.—Effect on modulus of rupture of additions of various bonding agents to a body composed of 50% English ball clay and 50% ground silica.

When used in glazes, gum tragacanth and gum karaya are generally added in amounts varying from $^1/_2$ to 1%, whereas about 3% of dextrine or gum arabic is added. A study of the curves in Fig. 1 would indicate that gum arabic probably would make the best adhesive agent for most glazes. Gum tragacanth, gum karaya, and dextrine show nearly equal transverse strengths in the amounts commonly used in glazes. Bindex is the trade

name of a new body bonding material that resembles dextrine in transverse strength as well as in some other properties.

Descriptions of Various Organic Bonding Agents

Gums are amorphous substances occurring in trees or plants, from which they are derived by spontaneous exudation or by extraction with solvents. They are perfectly nonvolatile, have little or no taste, are noncrystallizable, and eminently colloidal.[2]

There are two types of gums, those soluble in water such as gum arabic, and those that swell up in cold water such as gum tragacanth.

Gum Arabic

Gum arabic is derived from various species of acacia by exudation from the bark. It is also called gum acacia, gum senegal, Turkey gum, Sudan gum, or Kordofan gum. The term "gum acacia" is applied to the best varieties of gum arabic obtained from Sudan which are used chiefly in medicine. The collection of the gum is rather interesting and is begun by incising and stripping off the bark from trees three or more years of age. The first gum is collected sixty days after incision and collection continues on every fourth day until the rains set in.

The finest gum arabic of commerce occurs in colorless lumps of various sizes full of minute cracks. Gum senegal, a newer variety obtained from Senegal, forms yellowish or reddish lumps without the minute cracks of the better varieties. Gum arabic dissolves slowly in twice its weight of water and forms a thick mucilage of acid reaction. Its aqueous solution is precipitated by basic lead acetate, potassium and sodium silicate, borax, ammonium oxalate, mercuric chloride, and ferric salts. The addition of a saturated solution of aluminium sulphate to gum arabic solution is said to increase the adhesive properties of the latter greatly due to the formation of aluminium arabate, while calcium sulphate is gradually deposited. The quality of gum is judged quite well by testing its relative viscosity. A solution consisting of 10 grams of gum diluted to 100 cubic centimeters, when tested for speed of flow through an orifice, gives a good comparison with the best quality used as a standard.

Gum arabic is used to give luster to crepe and silk, to thicken colors and mordants in calico printing, in the manufacture of ink and blacking, as a mucilage, in medicine, and in the manufacture of confectionery.

The common practice with gum arabic, as used in glazes, is to add 3% to the mill batch. This method is quite satisfactory if the gum is well distributed throughout the batch, otherwise the gum will not dissolve and will merely "ball up" in the mill. If it is desirable to make up an aqueous solution of the gum before adding to the glaze batch the gum should be soaked in cold water over night, boiled next morning, and

[2] Allen, Commercial Organic Analysis.

sieved through a 40-mesh sieve. Due to its ready solubility in water (dissolves in twice its weight of water) a solution of gum arabic of most any desired strength may be had.

Gum Tragacanth Gum tragacanth is obtained as the gummy exudation from certain species of Astragalus which are small shrubs found in Turkey and Persia. In gathering, incisions are made and the gum flows out and dries. The shape of the incisions determines the form of the pieces such as "flake" or "vermicelli." If the weather is good the "white leaf" form is obtained, if it rains, or if the wind blows and dust is collected the gum becomes the "yellow leaf" variety. "Flake" tragacanth is the best variety, while "vermicelli" or "hog" tragacanth are inferior varieties. Gum tragacanth is often adulterated with cheaper gums, such as gum arabic, when in the powdered condition.

Tragacanth is usually white or yellowish (having sometimes been bleached with chlorine) but inferior varieties have a brownish color. It is hard, tough, difficult to powder, is odorless and tasteless, and insoluble in alcohol or ether. If allowed to soak in 50 times its weight of water, tragacanth swells up and forms a thick jelly-like mucilage without actually dissolving. A mucilage of tragacanth is colored yellow by sodium hydroxide, yields clear mixtures with borax, alkaline silicates, and ferric chloride, and is precipitated in clots by alcohol. As in the case of gum arabic, different grades of tragacanth may be compared by testing the viscosities of various solutions.

Gum tragacanth is used for stiffening crepes and calicos, for marbling books, as mucilage, and in pharmacy for giving greater firmness to pills and lozenges.

The proper method for making up a gum tragacanth solution is to soak the gum in cold water over night, or until the gum has swelled to the fullest possible extent, then to boil with more water until a thick homogeneous solution is obtained. The following method is given for making a good solution for glaze work. Add 6 grams of gum tragacanth (ground or sorts) to 500 cubic centimeters of cold water and allow to soak over night; boil next morning, with frequent stirring, for about fifteen minutes and make the solution up to 1000 cubic centimeters; pour solution through a 40-mesh sieve and allow to cool before using. One unit of glaze will require about one unit of solution, and solution should be ground with the batch.

Gum Karaya Gum karaya is obtained as a gummy exudation from certain species of tropical shrubs and trees. It is also called Bassora gum, gum sterculia, Indian tragacanth, or Kuteera gum. Gum karaya belongs to the gum tragacanth type (gums that swell up in water but do not dissolve), and is used quite extensively as a cheap substitute for gum tragacanth.

Gum karaya, when made into a solution of 1 gram of gum to 50 cubic centimeters of water, forms an uneven mucilage that forms into coarse uneven strings upon stirring (a distinction from tragacanth).

Gum karaya is used for sizes in the textile industry, as a base for commercial ice cream powders, as a filter in place of gelatine, and as a smoother by reason of its property of absorbing water.

In glazes, gum karaya acts as a good suspension agent and as a cheap substitute for gum tragacanth. The addition of a small amount of gum arabic to a solution of gum karaya seems to aid its adhesive properties considerably. Gum karaya solution may be prepared in the same manner as gum tragacanth.

Dextrine

Dextrine is produced by heating starch or flour at a temperature ranging from 210 to 280°C and by holding at this temperature until a yellow or brownish color develops. It may also be obtained by treating starch with diluted acids, or by the action of malt extract.

Pure dextrine is a white, amorphous, tasteless, odorless, nonvolatile, highly deliquescent solid. It dissolves completely in water forming a mucilaginous, neutral solution and is insoluble in absolute alcohol, ether, baryta water, and tannin.

Dextrine is used as an inexpensive substitute for imported Senegal and Arabic gums in technical industries. It is used for printing cloth and stiffening textiles, for caustic dyes, for producing colored paper and glazed cards, for gumming labels, for manufacturing inks, for making courtplaster and solid bandages, and is used in bread, fine pastry, and beer.

With reference to its use in glazes, dextrine is a fair adhesive and suspensive agent. In the shop practice of this company it is used instead of gum arabic in glazes that contain borax. Borax precipitates gum arabic from an aqueous solution and thus renders a glaze containing these two substances unsuitable for spray application. One peculiarity of dextrine is its action as an electrolyte or deflocculating agent in some glazes. The addition of about 3% of dextrine to the mill batch has been found to be quite satisfactory.

Gelatine

Gelatine, like glue, is prepared from the hides, skins, and bones of animals but is distinguished by its purity, its yellowish tint, its hardness and elasticity. It softens and swells up in cold water but does not dissolve; it dissolves completely in hot water and forms a very firm and almost colorless transparent jelly.

Gelatine is totally insoluble in absolute alcohol, ether, chloroform, benzene, carbon disulphide, and fixed and volatile oils. It is precipitated from its aqueous solution by an excess of alcohol, by saturation with ammonium, zinc, or magnesium sulphates and by phosphomolybdic and

phosphotungstic acids, tannin, mercuric chloride, and picric acid. Gelatine solutions will not gelatinize and may be kept in the fluid condition by adding strong acetic acid, zinc, magnesium and calcium chlorides, sodium iodide, sodium and calcium nitrates, etc. Incidentally, solutions of gelatine in strong acetic acid are used as liquid glues.

Some of the uses for gelatine are for culinary and medicinal purposes, for fining beer, wine, and other liquids, for forming capsules, and for coating pills. Gelatine is rendered palatable by adding acid and sugar.

Whenever it is convenient and practicable to apply a glaze to either green or biscuit ware with a brush, gelatine may be used to advantage. An equally important use, however, for gelatine is in reglazing ware that must be refired.

It is very difficult to apply a heavy coat of glaze to glazed ware that must be refired because the glaze will run down vertical faces and will not adhere well to the smooth surfaces. Two or more coats of glaze, not containing gelatine, may be applied by drying out each successive application; but this is a slow process.

Gelatine may be used to advantage for reglazing in the following manner: dissolve 1 part of ground or plate gelatine in 4 parts by weight of hot water; add 1 part of this solution to 6 parts by volume of glaze (the glaze should have previously been ground and set at 58 or 60 ounces weight per quart) stir thoroughly, sieve if lumpy, and allow to chill or gel. A light coat of this gelatine glaze may be applied to the glazed ware with a paint brush. It will then be possible to apply a heavy coat of glaze to the ware either by spraying or dipping.

In applying gelatine glaze with a brush to green or biscuit ware, each successive coat should be allowed to dry.

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SOME PROPERTIES OF GLAZE SLIPS[1]

By Edward Schramm and Robert F. Sherwood

ABSTRACT

Data are presented for a fritted glaze and a raw porcelain glaze giving the relation between viscosity and specific gravity and p_H of glaze slip. The influence of grinding on the properties of the slip and of the fired glaze is also discussed.

Introduction

The more extensive use of the casting process in recent years has led to considerable study of the physical properties of casting slips as an essential element of control. Glaze slips have had less attention. Reference may be made to the paper by J. B. Shaw on "American Clays for Floating Enamels"[2] and to the more recent work of J. R. Bowman on the "Changes in Viscosity of Clay Slips and Glaze Suspensions."[3] We have made certain observations from time to time on the physical properties of glaze slips and the effect of some of these properties on the fired glaze; it is the purpose here merely to record some of these experiences rather than to attempt an exhaustive treatment of this subject.

As with casting slips, specific gravity and viscosity are the two properties valuable for control. Glaze slips, although often of very low clay content are subject to variations analogous to those of body slips on aging and on the addition of electrolytes. It is, of course, well understood that glaze slips are maintained in a partly flocculated condition to give increased viscosity, to prevent running on application, prevent separation of constituents on settling, and to avoid the formation of the hard, dense sediment produced by dispersed slips. The effect of aging on viscosity was well brought out by Bowman.[3] The present experiments were arranged to eliminate the question of aging and of temperature variation.

Test Observations

Two glazes were used: A, a fritted cone 6 glaze for vitreous tableware; B, a raw cone 10 glaze for electrical porcelain. The former is applied by dipping, the slip being very heavy and viscous; the latter is sprayed and is of lower specific gravity and viscosity. Viscosity tests were made with the usual form of viscosimeter, and are recorded as time in seconds for the discharge of 250 cc. water (15 seconds).

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received December 28, 1928.

[2] *Trans. Amer. Ceram. Soc.*, **19**, 339–60 (1917).

[3] *Jour. Amer. Ceram. Soc.*, **10**, 508 (1927).

Viscosity and Specific Gravity without Additional Agents

The relation between viscosity and specific gravity is first given for both glazes without addition of electrolyte. After the tests the glazes were allowed to settle and the p_H determined on the clear liquid. There was no change in this value in either series, *i.e.*, the alkalinity was not in any way affected by dilution within the range employed but was evidently determined by the character of the glaze solids.

TABLE I

VISCOSITY VS. SPECIFIC GRAVITY

Glaze A		Glaze B	
Sp. gr.	Time flow 250 cc.	Sp. gr.	Time flow 250 cc.
1.739	36.8	1.738	66.4
1.727	30.6	1.712	40.0
1.716	28.2	1.691	29.8
1.698	24.4	1.648	22.6
1.684	21.6	1.612	20.0
1.652	20.8	1.582	18.3
1.630	19	1.562	17.7
1.602	18	1.544	17.4
		1.528	17.0
		1.510	16.9
		1.482	16.2

On all curves the large circle marks the normal working condition of the glazes.

Weight of Solids in Slips

Since in suspensions of solids in water the volumes are additive, if the true specific gravity of the glaze solids is known, from the specific gravity of the slip the weight of solids per liter of slip or the percentage of solids by weight can be calculated. Thus for glaze A:

Sp. gr. glaze solids $= S_1 = 2.65$

Let x = wt. solids per liter of slip

$\frac{x}{S_1}$ = vol. " " " " "

$1 - \frac{x}{S_1}$ = vol. water per liter of slip

If S = sp. gr. of slip, $x + 1 - \frac{x}{S_1} = S$

$x\,(S_1 - 1) = S_1\,(S - 1)$

$x = \frac{S_1}{S_1 - 1} \cdot (S - 1)$ kg. per liter slip $= 1.606\,(S - 1)$

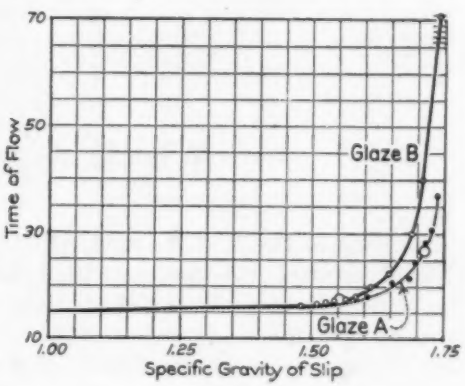

FIG. 1.

For glaze B, the specific gravity of glaze solids = 2.68 and the formula becomes $X = 1.594\,(S - 1)$.

Effect of Acids and Alkalis

To determine the effect of acids and alkalis on the glaze slips a number of 1-liter bottles were filled with each glaze at its normal working specific gravity, the glazes allowed to settle, portions of the clear water withdrawn and replaced with equal volumes of 30% acetic acid or 10% sodium hydroxide solution, thus altering the acidity with no sensible change in specific gravity. Viscosities were determined after ten minutes' blunging, the slips allowed to settle once more and the clear liquid withdrawn for p_H determination. The data are given in Table II and in the curves (Fig. 2). The last column in the tables gives the p_H obtained on making similar additions to clear water.

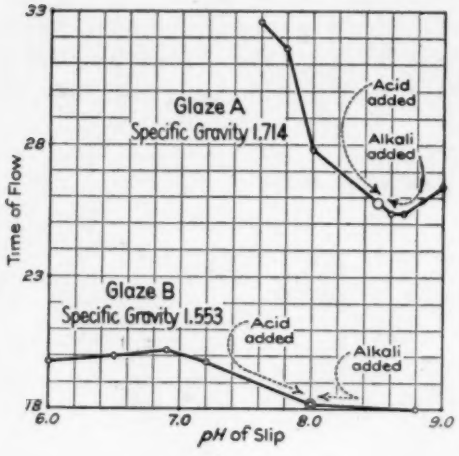

FIG. 2.

TABLE II

VISCOSITY VS. p_H

Glaze A—Sp. gr. 1.714				Glaze B—Sp. gr. 1.553			
Addition	Time flow	p_H slip	p_H water	Addition	Time flow	p_H slip	p_H water
None	25.8	8.5	7.9	None	18.2	8.0	7.8
1 cc. HAc	27.8	8.0	4.2	1 cc. HAc	19.8	7.2	4.2
2 " "	31.6	7.8	3.8	3 " "	20.2	6.9	3.6
3 " "	32.6	7.6	3.6	5 " "	20.0	6.5	3.4
1 cc. NaOH	25.4	8.6	11.4	7 " "	19.8	6.0	3.2
2 " "	25.4	8.7	11.7	1 cc. NaOH	18.0	8.8	11.4
4 " "	26.4	9.0	12.0	2 " "	18.0		11.7
6 " "	30		12.2	4 " "	18.7		12.0
				6 " "	18.0		12.2

Referring to Fig. 1, at the same specific gravities the porcelain glaze, B, gives higher viscosities than the fritted glaze, A, which may be attributed to the higher raw clay content of the former. From Fig. 2 it is noted that both glazes without addition of electrolyte are near the condition of minimum viscosity; that on addition of acid and base both suffer similar changes but of different magnitude, the heavy slip, A, giving a much wider range of viscosities than the thin slip, B. The absorption of hydrogen and hydroxylion by the glazes may be noted from Table II and Fig. 3. The glaze slips act as buffers over the range in which they are undergoing

marked changes in flocculation and maintain nearly constant p_H for considerable additions of acid and base.

Effect of Finer Grinding on Viscosity

The increase in viscosity due to finer grinding is illustrated in the curve (Fig. 4) for glaze A at a specific gravity of 1.745. It is seen that grinding is an important factor in determining the properties of the slip, and the effect of grinding is also apparent in the development of the glaze on firing. An experience of the writers several years ago is interesting in this connection. In making the frits a feldspar containing 7.50% potash, 3.21% soda was used and it was desired to substitute a feldspar with 9.86% potash and 3.21% soda. To maintain the same final glaze composition it was necessary to reduce the feldspar content and to compensate for the reduced soda by an increase in borax. These adjustments resulted in softer frits, which crushed and ground more readily and it was found that with the same time of grinding a more viscous glaze was obtained and the necessity of adding acid to the slip was obviated to a large extent. Particle size analyses of the new and old glaze by the sedimentation method gave the following results:

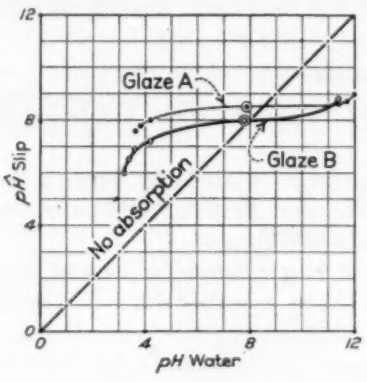

FIG. 3.

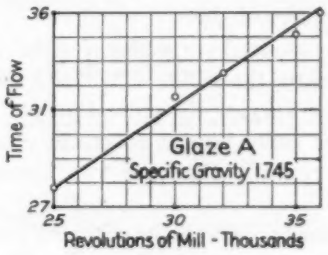

FIG. 4.

TABLE III

PARTICLE SIZE ANALYSIS OF GLAZES

Radius μ	New glaze 30,000 revs.	New glaze 32,000 revs.	New glaze 36,000 revs.	Old glaze 36,000 revs.
Over 8.3	16.0	12.4	12.3	13.3
8.3–2.5	40.6	41.8	35.3	43.1
Below 2.5	43.4	45.8	52.4	43.6

It is evident that with the altered composition of the frits we reached a degree of fineness between 30,000 and 32,000 revolutions of the mill corresponding to the former result at 36,000, and with the same grinding we produced a finer glaze. This change in conditions resulted in a generally improved appearance of the glaze at the same glost fire.

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THE MANUFACTURE OF FUSED BIFOCAL SPECTACLE LENSES[1]

By Robert J. Montgomery

ABSTRACT

I. The process of making fused bifocal spectacle lenses is based on patents taken out about 1906. Such lenses are made by fusing a crown glass with an index of refraction of 1.5230 with a lead glass having indexes of refraction of 1.616, 1.66, and 1.69. II. Problems in making satisfactory glass involved thermal expansion, surface crystallization, surface bubbles, and the softening temperatures of the glasses. The effect of composition of the glass in curing these defects is discussed and satisfactory compositions are given. Testing methods for control are given. III. A later development is the so-called colorless fused bifocal in which a barium glass replaces the lead glass of the normal lens. The use of barium glass introduces new problems, especially the quality of the glass and the tarnishing of the surface. The relative softening temperatures of the barium and crown glass as well as the thermal expansion had to be controlled.

I. Introduction

The term fused bifocal lens is applied to a spectacle lens comprised of two pieces of glass.

The desired correction for defective vision is obtained by varying the curves on the sections, varying the contact curve between the two lenses, and by varying the optical properties of the two glasses.

The early bifocal spectacle consisted of two separate lenses and it is only recently that the two lenses were fused together into one solid piece.

Prior to 1906 the bifocal lens was composed of (*a*) separate lens held in position by a special frame attachment, often on a hinge, to allow moving to one side when not in use; (*b*) single lens with a different curvature ground on the reading portion and known as a one-piece bifocal; and (*c*) segment of glass of different index of refraction cemented on the major portion.

The fused bifocal gives the advantages of the cemented bifocal without its disadvantages and has been used extensively since its manufacture was satisfactorily accomplished. One-piece bifocal lenses are used and improved methods of grinding have given good results, but they have never displaced the fused two-piece bifocal lens in general service, partly because of its higher cost.

The manufacture of the fused bifocal, after the idea was patented, gave the glass manufacturer new problems to solve. Three methods were suggested.

(1) U. S. Patent 827,500, 1906, by Chas. N. Brown, gives the idea embodied in the present fused bifocal. It is described as a method of making blanks for a composite lens, which consists in providing the members of

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.) Received November 21, 1928.

the blank with curved surfaces of different curvatures, placing the curved surfaces in contact and heating the surfaces to cause the surface of one curvature to change its shape and conform to the curvature of the other surface and unite them. (See Fig. 1.) The segment A has a stronger curve than the curve on the major lens B and allows the segment to soften and sink into position.

In 1907, U. S. Patent 865,363, to Carl F. Deickman of Kryptok Co., describes an improvement which has been used extensively. A wedge is inserted between the lenses at the edge as shown in Fig. 2. This allows the air to be pushed out from between the lenses as the segment softens and prevents air-pocket defects. The wedge is ground away in finishing the lens.

(2) U. S. Patent 848,335, to John Wimmer, describes a process of filling the countersink in the major lens with powdered glass and allowing it to melt into position by application of heat. The idea is shown in Fig. 3. This would not give a glass free from defects.

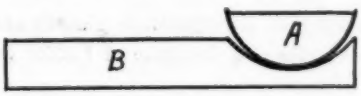

FIG. 1.

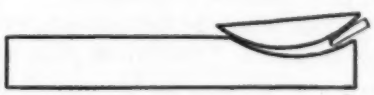

FIG. 2.

FIG. 3.

(3) U. S. Patent 890,813, to H. J. Stead, describes a method of blowing the crown glass in a mold to form the major lens with a countersink and also blowing the segment in a mold, the two being joined while still hot and plastic. Accurate curves could not be obtained by this method.

Methods (2) and (3) were found to be impractical. A powdered glass could not be melted down into position without defects of bubbles and striae in the segment and distortion of the curves between segment and major lens. The blowing method would not allow the control of curves within the limits necessary for optical use. The fusion into a single lens of two prepared lenses was found to be possible under controlled conditions. Several other patents describe slightly different methods of making the fusion, different sizes and shapes of the segment, the use of more than one segment, the index of refraction of the glass and methods of making the fusion, but these patents have little bearing upon the method and materials established by practice in the industry.

For cemented bifocal lenses two glasses are used. The major portion is a crown or soda-lime glass and the segment is a lead or flint glass. The

crown glass has an index of refraction of 1.5230 for the D line of the spectrum, while three flint glasses in common use have indexes of refraction of 1.616, 1.66, and 1.69 for the D line.

The procedure is to prepare both major lens and segment with properly ground and polished curves. The segment is mounted in position with the wedge in place. The wedge is usually held in position by a cement such as silicate of soda and barium sulphate. The lenses, mounted on refractory supports, are then placed in a furnace and heated till the segment softens and settles into position. To do this the segment must have a lower softening point than the major lens, so that the segment will soften without distortion of the curve ground and polished in the crown glass. The fused lens is then cooled slowly to anneal. After cooling, the lens is ready for the finishing, grinding and polishing of the outside curves.

Usually an electric furnace is used, the continuous tunnel type being very effective. The maximum temperature is about 1250°F. The cooling zone of the tunnel type of furnace must be long enough to give good annealing or the glass must be re-annealed.

In 1906 when the first patents were taken out, the spectacle glasses used were imported. The crown glass with an index of refraction of 1.5230 was already a standard for the manufacture of spectacles.

High losses in the process of manufacturing were the rule. The fusion was carried out in America with the glasses available, with little knowledge as to their composition and properties.

The war cut off importation from Europe. Spectacle glasses were developed in America. Several firms, including the Pittsburgh Plate Glass Company, the Corning Glass Company, and the Bausch and Lomb Optical Company, developed glasses which were more or less satisfactory. The following discussion is a record of certain research work carried out in the glass plant of the Bausch and Lomb Optical Company in the development of glasses which have been very satisfactory. The principles involved are discussed. Actual glass compositions are given only to make the points clear, as compositions will vary with each plant and depend upon local conditions.

In addition to the use of the normal crown and flint glasses there has been a recent demand for a corrected lens in which the mean dispersion of the glasses, as well as the index of refraction, is under control. These new glasses will be discussed in the latter part of this paper.

II. Requirements and Defects

The requirements for glass for fused bifocal lenses are very exacting. In the early days when the process was protected by patents, high manufacturing loss could be absorbed, but the patents have now expired and costs are more important. Both crown and flint glasses must be of high

quality in respect to color and striae and of correct optical properties. The softening point and coefficient of expansion must be under control so that successful fusions may be made free from distortion and strain. The contact surfaces between the glasses must be free from "fog" and bubbles.

There are the striae, bubbles, and color problems which apply to all spectacle glass and not primarily to fused bifocal lenses. There are also (*a*) strain, (*b*) "fog," (*c*) surface bubbles, and (*d*) distortion, which apply directly to fused two-piece lenses.

(1) Strain

The two glasses to be fused together must so match in expansion that on cooling, after fusion, the lens will show the least possible strain in polarized light. The most simple form of fusion would be two pieces of the same glass, the expansion would be identical, and any strain present would be due to poor annealing. When the glasses are dissimilar, as a crown glass to be fused with a flint glass, several new factors are introduced. The glasses may have the same total expansion but not the same rate of expansion for all temperatures, and the softening temperatures are not the same. The flint glass softens at a lower temperature than the normal crown glass. We find that it is practically impossible to obtain two dissimilar glasses with the same coefficient of expansion throughout the range from room temperature to fusion temperature.

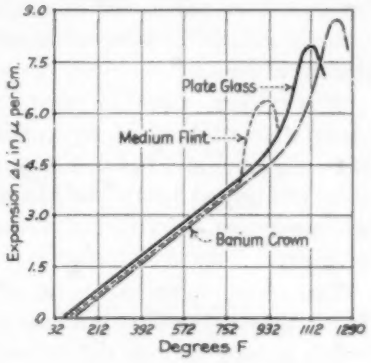

FIG. 4.—Thermal expansion of glass by Peters and Cragoe.

Donald E. Sharp[2] gives a method of drawing a stem of two glasses fused together and judging their relative expansion by the bend of the drawn stem. A flint-crown glass combination which will fuse without strain gives a stem which bends toward the crown. Annealing strains are present in such stems as well as strains due to differences in expansion. This test can be used only as a general indication of the strain between two glasses, after one has learned to interpret the results.

Peters and Cragoe[3] made observations on thirty-two glasses up to 1200°F. They found that glass passes through a critical expansion region

[2] *Jour. Amer. Ceram. Soc.*, **4**, 219 (1921).

[3] "Thermal Dilation of Glass at High Temperatures," U. S. Bur. Stand., *Sci. Paper*, No. 393.

in which the expansion rate increases by two to seven times. This critical range does not exceed 75°F and is about 150°F below the point where the glass softens and contracts. Three curves from this work are given in Fig. 4 for a plate or crown glass, a lead glass, and a barium glass. The barium glass curve will be referred to in the latter part of this paper. While the composition is not given, the crown and flint glasses represent, in general, the types of glass used for bifocal fusions.

The temperature for fusing bifocal lenses is 1150 to 1400°F or at a point where the crown glass becomes fairly soft and the flint glass has reached the deformation or contraction stage. When a crown and flint glass are fused together, the rate of expansion of the flint will change at about 770°F, while the expansion rate of the crown changes at 1000°F. This rate of expansion change complicates the matching of two glasses and makes it impossible to make two dissimilar glasses which will have the same expansion rate at all temperatures up to the temperatures at which bifocal fusions are made.

It is evident, therefore, that a glass fusion may be practically free from strain when cold but might contain considerable strain at some temperature between room and fusion temperatures. It also might be practically free from strain just below the fusion temperature where the glass is set and will no longer deform, but be badly strained when cooled to room temperature. This is just what is found in practice.

The actual temperature at which this change takes place is of minor importance. It will depend upon the composition of the glass in question, which in turn controls the softening point of the glass and the tendency to distort on fusion.

The usual factory method of determining whether two glasses will fuse together without strain is to fuse them, grind and polish the lens, and if it does not crack it is considered to be satisfactory. This rather crude method gives no distinction between annealing and fusion strains. A new method of testing was developed which would give exact information as to what strain was present and allow the corrections necessary in batch composition when the strain due to fusion was excessive.

For some time the lenses were examined through the flats in polarized light, using a tint plate to show double refraction colors as described by F. E. Wright.[4]

It was found that lenses which showed little or no strain with this examination, would crack on polishing, proving that strain was present. A segment was cut from the lens and the lens was looked at through the edge. It was found that even though no strain showed through the flats, the lens might contain very heavy strain when examined through the edge.

[4] *Jour. Opt. Soc. Amer.*, 5 [5], Sept. (1921).

The strain evidently was equal and opposite in the segment and major lens, resulting in a neutralization when examined through the flats. It is quite easy to distinguish between fusion and annealing strain by examination through the edge before and after re-annealing. The amount of color or strain showing will depend upon the thickness of the segment; 15 mm. was used as a standard. If this dimension is reduced to 9 mm., the strain is materially reduced; so for comparative results the 15 mm. or some standard must be adhered to.

The amount of strain is indicated by the number of colors showing and whether the strain is tension or compression is indicated by the order or distribution of the colors. The colors obtainable are given by Alexander N. Winchell.[5] He gives the color table of double refraction. This table starts with a neutral gray and goes through four orders of colors. The colors are more or less repeated in each order, getting fainter as the order number increases. These colors are given in the table below with the neutral color pink or red marked, which indicates no strain with polarized light, crossed-nicols, and sensitive tint plate.

First Order	Gray Yellow Orange-yellow Red Violet	Third Order	Blue Green-blue Green Yellow Orange-yellow Red Violet
Second Order	Blue Green-blue Green Yellow Orange-yellow Red (neutral tint or no strain) Violet	Fourth Order	Blue Green-blue Green Yellow Orange-yellow Red Violet

It is not certain that the red of the second order as indicated is the neutral tint seen and not the red of the first or third order, but from the standpoint of practical use this is unimportant.

In a badly strained piece of glass more than one order of color may be seen on each side of the neutral red tint. It is beyond the scope of this paper to explain the optics of this point. It is important to note, however, that the whole color distribution would be changed if the sensitive tint plate is put at right angles to its previous position. The adjustment of the instrument must be the same at all times.

Whether the colors seen in the glass go up or down the scale depends upon the strain, whether it is tension or compression, and the position of the tint plate on the instrument. The tint plate was set at an arbitrary position showing the neutral color with a piece of well-annealed glass and a

[5] Optical Mineralogy, Van Nostrand Co.

good distribution of color when looking at a strained piece. The position is checked each time it is used by re-inspecting a standard sample which has its color distribution charted. A rotation of the tint plate 90° will reverse the order of colors and indicate the reverse direction of strain.

In a few cases blue or yellow were found in both segment and major lens and the writer did not understand these cases. The total amount of strain is small. It may be caused by a thin layer of striae on the surface or some such unusual thing.

To determine the relation between color and strain direction with a certain setting of the tint plate, a block of glass was put under compression by the use of a clamp on the edge to get compression along the outer edge. Blue then indicates compression under the conditions used. If the tint plate is rotated 90° the color would be yellow, hence a standard position of the tint plate is necessary.

The following two charts are of great aid in correcting batch compositions when the tint plate is correctly set.

RELATION OF COLOR TO STRAIN

Segment ↑ ↓ Major lens		Segment ↓ ↑ Major lens	
Yellow	Blue	Blue	Yellow
Coeff. high	Coeff. low	Coeff. low	Coeff. high
Tension	Compression	Compression	Tension
↓ ↑		↑ ↓	

COLOR AND STRAIN NOTATIONS USED

1 color	Fair as blue
2 colors	Decided as blue-green
3 "	Heavy as blue-green-yellow
4 "	Very heavy as blue-green yellow-red

An example of just how a correction is made is as follows:

A major lens made of Crookes glass showed considerable strain when fused with the standard flint segment. The strain record was

Segment	Blue-green-yellow
Major lens	Yellow-green
Strain	Heavy

Referring to the chart on "Relation of Color to Strain," it is found that the major lens is yellow (the first color next to the neutral red, going toward the line of fusion between the segment and major lens), the coefficient of expansion is high, giving tension in the major lens. In order to reduce this strain the coefficient of expansion of the major lens must be reduced. The sodium carbonate content of the batch was lowered from 90 to 86 kg. Glass of the new composition fused with very little strain. The strain record was:

Segment	Slight blue
Major lens	Slight yellow
Strain	Good

The amount of strain present may be neglected. The correction of strain is satisfactory and manufacturing losses were reduced.

Strain on Reheating

In several cases fused bifocal lenses cracked while being re-annealed to relieve annealing strains. Examination showed that there was not enough strain present to cause cracking. Evidently at some time during the heating and cooling of re-annealing, a strain great enough to crack the glass was introduced. In order to clear up this point fused lenses were cut so they could be examined through the edge. The prepared samples were heated in a gas furnace and placed in such a position that a beam of polarized light could be sent through the test pieces while in the furnace. The furnace containing the test pieces was placed between the glass plate and the sensitive tint plate of Wrights. Small glass windows were placed in the front and back of the furnace in line with the samples. Care had to be taken that there was no strain in the glass used for the windows as this would interfere with correct observation. The three following examples give a good idea of what was obtained with this test:

(1) Pittsburgh Plate Glass Company's crown with Bausch and Lomb flint glass
(2) Bausch and Lomb crown and flint glass
(3) Bausch and Lomb Crookes and flint glass

The furnace was slowly heated to 900°F which is above the critical annealing temperature of the flint glass. Figure 5 shows the relation between the temperature increase and the resulting strain in the glass, either tension or compression, as the case might be. The amount of strain was based upon the color distribution in the major lens. The neutral (no strain) or red is shown at the center. Above the neutral line indicates increasing tension, while below indicates increasing compression.

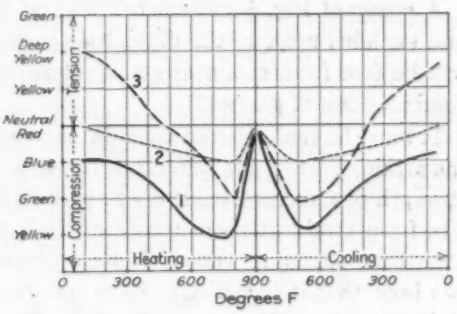

FIG. 5.—Color or strain in major lens.

(1) The Pittsburgh crown showed some compression strain at room temperature. This increased as the temperature increased until the glass became soft enough to relieve the strain at about 800°F. On cooling the same amount of strain was introduced as was there originally, and the curve returned to its starting point showing some compression at the end of the test. This returning to the original amount and type of strain was obtained in all cases and indicates that re-annealing has no effect in increasing or reducing the strains due to differences in coefficient of expansion.

(2) The Bausch and Lomb crown and flint glass combination showed no strain or neutral color at room temperature but showed compression in increasing amount as the temperature increased to the softening point.

(3) The Bausch and Lomb Crookes glass showed considerable tension at the start which decreased with temperature increase until the strain entirely disappeared at about 500°F. A further temperature increase caused compression which continued to increase until the softening temperature was reached. On cooling the curve was reversed. The compression was lost and the tension returned as was observed at the start.

In production combination No. 1 often cracked on re-annealing while combinations Nos. 2 and 3 did not crack. A study of the graphical representation in Fig. 5 will make it plain why this is so. Curve No. 1 shows that with this combination of glass the compression strain increased on heating to the point that it sometimes ruptured the glass. This was especially true when extra thick lenses called "punktal" were made. In combination No. 2 the strain increased, but not to the point where it would rupture the glass. With combination No. 3 a considerable change in strain was observed, but it decreased with the first increase of temperature and never was so great as that shown in curve No. 1. If curve No. 3 had started at neutral or with compression, in all probability it would have cracked on re-annealing as the compression strain would have been greater than in curve No. 1.

A study of Fig. 5 gives a fair idea of what happens in a bifocal fusion and explains most of the difficulties encountered in making fusions which will be free from strain at room temperature and in re-annealing certain combinations of glasses.

It must be remembered that the heavier or thicker the glass the greater the strain, even if the difference in expansion coefficient is constant. The strength of the curve itself does not seem to make any difference. A glass free from strain at room temperature may have been under heavy strain some time during its cooling from the fusion temperature. Our experience has been that it is better to have tension in the crown or major lens than to have compression, especially if the glass is to be re-annealed.

Correction of Strain

The alkali is the constituent usually varied as it has little effect upon the optical properties of a glass. All constituents have an influence upon this property. Winklemann and Schott[6] and Mayer and Havas[7] have determined factors for the calculation of the coefficient of expansion of silicates or glasses.

While these factors can be used to advantage to indicate in a general way what constituent to vary, and how much, in making a correction for

[6] Jena Glass by Hovestadt, p. 217.

[7] Mayer and Havas, *Sprechsaal*, vol. 42, p. 497; vol. 44, pp. 188, 207, and 220.

expansion, exact calculations do not apply in making bifocal fusions. It was found with the glass compositions used that a crown glass with a calculated coefficient of 261×10^{-7} will require a flint glass with a calculated value of about 247×10^{-7}. A flint glass with a value of 251×10^{-7} or 244×10^{-7} would give strain, compression in one case and tension in the other. The limits seem to be quite narrow or between 246 and 249 $\times$ 10^{-7} for successful fusions. Two glasses of dissimilar composition like a crown and flint glass cannot be directly compared on this basis.

Drawing two glasses into composite threads, after heating to softness in a flame and determining the relative expansion by the bend, did not answer for testing glasses for bifocal fusions. If a certain curve, the amount to be determined by experience, was obtained there was a fair probability that the two glasses could be satisfactorily matched after corrections were made. This test, therefore, is of value as a rough approximation. The only safe test seems to be with polarized light as already described.

(2) Fog or Surface Crystallization

A common defect in fused bifocal lenses is a haze or fog on the surface of the contact curve between the major lens and segment. This "fog" is difficult to see and can only be detected after the lens is ground and polished on both sides. If the "fog" is heavy it can be seen in ordinary light, but special illumination and an experienced inspector is required to detect an amount of "fog" which will cause rejection.

This fog is a surface crystallization of tridymite. Surface crystallization will take place at temperatures much below that at which crystallization will take place throughout the glass mass.

It was found that fog was obtained more readily when a flint glass with an index of refraction of 1.616 was fused with the crown glass than when a flint glass with an index of 1.66 or 1.69 was used. The flint glass with an index of 1.616 requires a higher temperature to soften it and contains a higher per cent of silica, so this is to be expected.

Bowen[8] discusses devitrification in glasses and reports the surface devitrification of a flint glass with an index of refraction of 1.62, showing crystals of tridymite at 1670°F. He found crystals of silica and calcium silicate on the surface of an ordinary crown glass when heated to 1292°F. In the laboratory crystals were developed on the crown glass by holding for some time at 1250°F, the temperature reached in fusing bifocals. Recent work by Kozo Tabata[9] records surface devitrification as low as (600°C) 1112°F. He concludes that the amount of crystallization de-

[8] *Jour. Amer. Ceram. Soc.*, **2**, 261 (1919).
[9] *Ibid.*, **10**, 6 (1927).

pends largely upon surface tension which is affected by the condition of the surface as well as temperature and composition.

The great tendency of silica to crystallize on the surface, when the glasses were heated to the point where they would fuse together, was recognized and the problem was solved by varying the composition of the glass to control the softening temperature and viscosity which indirectly controlled the surface tension at the temperature of fusion. The necessity of maintaining the necessary index of refraction, coefficient of expansion, and good quality of glass while varying the composition made the problem very difficult. The cut-and-try method was used largely, based, however, upon a rather definite knowledge of what to expect from each material used. Complete fused bifocal lenses were made of each test glass and determinations of index of refraction, strain, and tendency to fog were recorded.

(3) Surface Bubbles

Another cause of many rejections of fused bifocal lenses is the formation of bubbles on the surface of contact between the flint and the crown. Often only one or two very small bubbles are seen, but one bubble will cause rejection. It is undoubtedly true that many such bubbles are due to dirt or dust on the glass which gives off a gas on being heated. The gas is entrapped between the two glasses during fusion. Great care in cleaning the major lens and segment and washing the air used in the fusing room to remove dust will reduce the losses from this cause, but it seems probable that the glass itself may give off gases at the fusion temperature (1250°F). While an understanding of this defect is desirable, losses from this cause usually are not high enough to justify an attempt to change the glass composition and risk the danger of increasing the loss from some other defect. A survey of the literature on the subject suggests three possible causes for bubble formation.

(A) Chemical Reactions Glasses tarnish when exposed to air and may be affected by cleaning solutions. Compounds may be formed which would give off a gas on heating, possibly carbon dioxide. A very minute amount of gas would be required to form a bubble which could be seen. Laboratory tests show that a distinct weathering action is obtained in thirty days' exposure. Eldsden, Roberts, and Jones[10] report surface films formed on glass in thirty hours, when exposed to air saturated with water vapor at 80°C. Glass is often held in stock for some time before it is used and opportunity is given for a slight weathering action which could not be seen but which could easily account for the small amount of gas required for one small bubble.

[10] "Examination of Optical Glass in Relation to Weathering Properties," *Jour. Soc. Glass Tech.* (Aug., 1919).

(B) Absorbed Gas During the melt the glass is in contact with an excess of gas and it dissolves or absorbs quite a large amount. E. W. Washburn[11] has made analyses of the gas obtained by heating a glass under vacuum. While the glass will not give off enough gas to cause bubbles to form in the interior of the lens it is possible that the surface will give up a certain amount at the temperature of bifocal fusion.

(C) Adsorbed Gases Irving Langmuir[12] reports work done in the laboratory of the General Electric Company on the adsorption of gases on plane surfaces of glass, mica, etc. On heating glass to 300°C he obtained 1.3 cu. mm. of water vapor per sq. cm. of surface; 2.2 cu. mm. were obtained at 450°C showing the loss progressive and not complete at the lower temperature. Another test at 300°C gave 0.18 cu. mm. of water vapor, 0.032 of carbon dioxide and 0.025 of nitrogen, giving a total of 0.237 cu. mm. per sq. cm. These figures were considered as low because of the short time of heating and because the glass had been heated a short time before the test. This was for a soda-lime glass. Adsorption at low temperatures only is reported in this paper and what may happen at 600 to 700°C is not given.

There is reason to believe that gas is given off by glass with increase of temperature and that an appreciable amount will be evolved at 1250°F. The composition of the gas is probably carbon dioxide and nitrogen. An excessive temperature during the fusion process will increase the losses due to bubbles.

(D) Distortion The curve ground in the major lens, which is composed of crown glass, must be maintained if proper optical corrections are to be made. A slight distortion during the fusion, due to excessive softening of the glass, will give distortion of vision and the lens will be worthless. The crown glass must then be heated to a point which will allow welding between the major lens and the segment but no distortion of the curve. This result can be obtained only because the flint segment softens at a lower temperature than the crown or major portion. Also the heat is applied largely from above and the major portion is kept cooler by contact with the bottom of the furnace which is relatively cool. The softening temperature of the crown glass is about 1250°F as compared to about 1050°F for the flint glass. Fortunately, this difference of 200°C in softening temperature will allow satisfactory fusions without distortion and the composition of the glass does not have to be altered to control this property. Some recent combinations using glass other than the normal flint and crown have given a great amount of

[11] Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 18.
[12] *Jour. Amer. Chem. Soc.*, **40**, 1361 (1918).

trouble from distortion because of the difficulty of controlling the softening temperature.

(4) Composition of Crown Glass

As before stated the major portion of the lens is a soda-lime glass. In composition it is very much like a plate glass but has a higher index of refraction than most plate glass. The index of refraction for the D line of the spectrum of most plate glass is about 1.51 while that of spectacle crown is 1.5230. This higher index of refraction is usually obtained by an increase in the lime content. The high lime content gives a hard, durable glass with a rather high softening point. Glass made by different companies will differ somewhat. The following analyses are examples:

TABLE I
COMPOSITION OF CROWN GLASS

	1	2	3	4
Silica	71.73	72.31	71.36	69.04
Aluminum oxide	0.3			
Zinc oxide	0.15			
Calcium oxide	11.8	10.75	12.26	12.07
Sodium oxide	14.42	15.19	14.49	5.95
Potassium oxide				11.75
Antimony oxide	0.21	.1.48		0.90
Arsenic			1.43	
Boron oxide		0.27	0.26	0.25

Number one is a German imported glass while the other three are made in the United States.

(5) Composition of Flint Glass

The flint glasses used for the segment are based upon normal optical glasses of the required index of refraction and controlled to give freedom from the defects already mentioned. There are several glasses on the market, all of which are used in production. No record is available as to their relative value and freedom from defects. The flint glass with an

TABLE II
COMPOSITION OF FLINT GLASS

Index of refraction	1.616			1.66		1.69
	1	2	3	4	5	6
Lead oxide	47.54	45.01	45.50	52.67	54.18	57.90
Silica	45.30	47.76	44.45	40.00	39.16	36.96
Aluminum oxide	1.62	0.29	0.31	0.13		
Calcium oxide				2.36		
Sodium oxide	3.14	3.28	1.01	1.98		
Potassium oxide	2.26	3.23	8.40	2.94	6.09	4.39
Arsenic oxide	0.22	0.10	0.20	0.15		
Antimony oxide					0.56	0.74
Zinc oxide		0.13				

See "Composition of Lead Glasses," *Jour. Amer. Ceram. Soc.*, **3**, 900 (1920) for normal compositions of lead optical glasses.

index of refraction of 1.616 is the one most apt to give fusion defects while those with an index of 1.66 and 1.69 often contain the quality defects of striae and bubbles. Several compositions are as given in Table II.

(6) Experimental Melts to Eliminate Fog

The obtaining of a flint glass with an index of refraction of 1.616 which would not show fog, while fusing without strain and being of good quality, was a big problem. The 1.66 and 1.69 flint glasses are not so apt to show this defect. Many semicommercial melts, containing from fifty to seventy-five pounds of glass, were made and each glass was fully tested. Smaller melts gave glass of such poor quality that exact determinations could not be made. The following glass, which was satisfactory except for fog, was used as the basis of most of these melts:

Base Glass 304

Lead oxide	44.01
Silica	46.89
Potassium oxide	2.63
Sodium oxide	4.70
Calcium oxide	1.61

This composition is very near to the composition given under "Composition of Flint Glass." The low lead content is offset by the presence of lime. Small changes in composition often give an unexpected poor quality of glass, in melting behavior, bubbles, etc. Melts in pots smaller than 15 inches in diameter and made without stirring during the melting period would not give reliable information in regard to quality and a glass good enough to determine the optical properties, strain relations, and tendency to fog. The divisions of this investigation are as follows:

(A) Use of feldspar
(B) Variation of sodium content with low potassium
(C) Variation of sodium content with high potassium
(D) Silica content
(E) Potassium versus silica
(F) Boric acid content
(G) Use of alumina
(H) Use of zinc
(I) Use of calcium
(J) Potassium content
(K) Use of antimony
(L) Glass based on analysis of French flint
(M) Conclusions

(A) Use of Feldspar Experimental melts containing feldspar gave such poor quality glass that fusion tests were not made. Feldspar evidently will not give a satisfactory boil in the base batch used and while the presence of alumina in the glass might aid in the prevention of fog the quality of the glass is sacrificed. Only two or three melts were made.

(B) Variation of the Sodium Content with Low Potassium

The notation refers to the bubbles in the experimental melt as it came from the pot. Striae are not considered in this inspection since glass good for striae is almost never obtained in a pot of this size (15 inches in diameter). The fog is noted as none, light, medium, or heavy, depending upon the report of an experienced inspector.

TABLE III

	415	304	372	369	374	367
SiO_2	44.71	46.89	47.20	47.20	48.00	47.20
K_2O	2.00	2.63	2.60	2.60	2.40	2.60
Na_2O	6.43	4.70	4.30	4.00	3.70	3.70
CaO	1.00	1.61	1.50	1.50	1.50	1.50
PbO	45.70	44.01	44.24	44.54	44.24	44.84
As_2O_3	0.16	0.16	0.16	0.16	0.16	0.16
Quality	Poor	Fair	Fair	Poor	Poor	Poor
Fog	Light	Heavy	Heavy	Heavy	Heavy	Heavy

None of the glasses in this division gave good quality. The best were those which contained an intermediate amount of sodium, Nos. 2 and 3.

Evidently fog occurs with a considerable change in the sodium content when potassium is low. The only one showing a tendency not to fog was No. 1, which contains the highest amount of sodium and is lowest in silica. The effect of the silica content is not definitely brought out by these melts but there is a tendency to have less fog with a low silica content, provided this is not carried too far.

(C) Variation of Sodium Content with High Potassium

As the sodium decreases and potassium increases the quality of the glass becomes better. Probably No. 395 is the best in this group and undoubtedly would give good glass if melted in a full-size pot. The others marked fair might give usable quality if made on a commercial scale. The important point is that the higher per cents of sodium seem to affect the boil and prevent the glass from fining easily.

TABLE IV

	379	435	377	395	375	441
SiO_2	44.40	46.20	44.00	45.71	45.71	45.60
K_2O	5.00	5.00	6.43	6.43	6.43	9.10
Na_2O	4.00	3.50	3.00	2.00	1.00	
CaO	1.50		1.50		1.00	
PbO	44.94	45.14	44.91	45.70	45.70	44.10
As_2O_3	0.16	0.16	0.16	0.16	0.16	0.30
B_2O_3						0.85
Quality	Poor	Poor	Fair	Almost good	Fair	Fair
Fog	Light	None	None	None	Medium	Light

Evidently a zone of compositions has been passed through which gives no fog. With sodium above 3.5% the tendency to fog is strong while with 1% or less fog is again encountered. The high potassium combined

with a medium silica content evidently gives freedom from this defect. With the alkali content from 8.4 to 8.5% the silica in the glass must be below 47% in order to obtain correct optical properties. Necessarily then the silica content must be lower than that in base batch 304.

(D) Silica Content It is impossible to get the effect of one constituent because one change always necessitates another and in a glass of this kind where the optical properties must be maintained, considerable care in substitutions is necessary. In this series zinc and calcium are introduced to take the place of the reduction in silica.

In general the quality improved with a decrease in silica. The limits for glass of this type are rather narrow and are between about 42.5 and 46.0%.

All this series is fairly good for fog; the two extremes show a slight amount on some of the samples tested. The intermediate silica content seems to be safer and the limits might be a little narrower than that required for good quality glass.

TABLE V

	427	395	376	399	409
SiO_2	46.19	45.71	44.71	43.41	42.41
K_2O	6.65	6.43	6.43	6.43	6.43
Na_2O	2.07	2.00	2.00	2.00	2.00
PbO	43.89	45.70	45.70	45.00	45.00
As_2O_3		0.16	0.16	0.16	0.16
CaO	1.03		1.00	1.00	1.00
ZnO				2.00	3.00
Sb_2O_3	0.16				
Quality	Poor	Almost good	Fair	Almost good	Good
Fog	Light	None	None	None	Light

(E) Potassium vs. Silica This really means an increase in the acid content of the glass with a decrease in the basic flux material.

TABLE VI

	401	396	393	342	386
SiO_2	44.70	44.71	46.20	46.70	47.20
K_2O	7.00	6.43	5.50	5.00	4.50
Na_2O	3.00	3.00	3.00	3.00	3.00
PbO	45.14	45.70	45.14	45.14	45.14
As_2O_3	0.16	0.16	0.16	0.16	0.16
Quality	Good	Good	Good	Good	Fair
Fog	Medium	None	None	Medium	Medium

With the exception of the one extreme, No. 386, the quality of all the members was quite good, probably the best glass of the entire investigation in this respect. With No. 386 the silica evidently becomes too high and the amount of base or flux present is hardly enough to take care of this per cent of silica. Number 304 also contains about 47% silica but the quality is not good and evidently is just beyond the safe composition for easily fined glass.

This series contains 3% sodium which is considered to be very nearly the maximum allowable content for this constituent. The field of glasses which will not give fog is evidently crossed; the two extremes fog, while the intermediate members do not show this. This gives an idea of how narrow the field is for actually good glass with the sodium as high as 3%.

(F) The Boric Acid Content Three contain boric acid while batch 304 is given for comparison.

An examination of the glass obtained indicates that the quality is somewhat improved by the addition of boric acid. A better proportioned base glass might have allowed the drawing of more definite conclusions. The presence of alumina makes it difficult to judge, but it seems that a better proportion of silica and alkali will do more to improve the quality than boric acid. The last two members containing alumina were quite yellow in color and not as good for color as normal flint glass.

TABLE VII

	304	385	437	439
SiO_2	46.89	46.38	44.25	42.25
K_2O	2.63	2.63	2.63	2.63
Na_2O	4.70	4.70	4.70	4.70
CaO	1.61	1.61	0.50	0.50
PbO	44.02	44.02	44.65	44.65
B_2O_3		0.50	2.00	4.00
As_2O_3	0.16	0.16	0.16	0.16
Al_2O_3			1.11	1.11
Quality	Fair	Almost good	Fair yellow	Fair yellow
Fog	Medium	Heavy	None	None

No definite conclusion can be drawn from this series. The fog in No. 385 was worse than with No. 304 and this would tend to condemn the use of boric acid. The last two members did not fog even with 4% of boric acid. The introduction of alumina evidently prevented fog as the base glass will fog. To obtain reliable results additional melts would have to be made using boric acid in our better proportioned glasses which do not fog.

(G) The Use of Alumina These batches are divided into three groups to facilitate discussion.

TABLE VIII

	Group 1				
	304	379	389	394	380
SiO_2	46.89	47.32	47.12	46.88	46.88
K_2O	2.63	2.68	2.68	2.63	2.63
Na_2O	4.70	4.76	4.76	4.70	4.70
CaO	1.61	0.27	0.27		0.50
PbO	44.01	44.61	44.61	45.02	44.02
As_2O_3	0.16	0.16	0.16	0.16	0.16
Al_2O_3		0.20	0.40	0.61	1.11
Quality	Fair	Fair	Poor	Poor	Poor
Fog	Medium	Heavy	Medium	Medium	None

	Group 2				Group 3
	437	439	438	440	403
SiO_2	44.25	42.25	44.25	44.25	47.11
K_2O	2.63	2.63	2.63	2.63	2.63
Na_2O	4.70	4.70	4.70	4.70	4.70
CaO	0.50	0.50	0.50	0.50	
PbO	44.65	44.65	44.65	44.65	44.60
As_2O_3	0.16	0.16	0.16	0.16	0.16
Al_2O_3	1.11	1.11	1.11	1.11	0.80
B_2O_3	2.00	4.00			
ZnO			2.70	2.00	
Quality	Fair	Fair	Poor	Poor	Poor
Fog	None	None	None	None	Heavy

Al_2O_3 from lepidolite.

The quality of the glass became poorer as the alumina increased in amount. This is particularly evident in Group 2, where the effect of the alumina is partly overcome by the use of boric acid and the glass was marked fair instead of poor. Zinc does not overcome the action of alumina. In Group 3 the one glass is a special one using lepidolite which introduces some lithium as well as alumina. The color of the glass was blue and the boil was very poor. Apparently conditions were not right for its use.

With batch 304 as a base Group 1 shows the effect of the increase in alumina. The tendency to fog decreased until it disappeared with the last member containing 1.11% alumina. The effect of alumina in preventing fog is shown also in Group 2. The glass evidently would fog if it were not for the alumina content. The single member of Group 3 fogged and as we were not interested in this glass because of its poor quality no further work was done.

(H) The Use of Zinc

Ten glasses are listed and divided into two groups as follows:

TABLE IX

	Group 1, low K_2O				
	304	382	440	436	404
SiO_2	46.89	45.88	44.25	44.25	44.52
K_2O	2.63	2.63	2.63	2.63	2.67
Na_2O	4.70	4.70	4.70	4.00	4.76
CaO	1.61	1.61	0.50	0.50	
PbO	44.02	44.02	44.65	44.65	44.88
As_2O_3	0.16	0.16	0.16	0.16	0.16
ZnO		1.00	2.00	2.70	3.00
Al_2O_3			1.11	1.11	
Quality	Fair	Fair	Poor	Poor	Poor
Fog	Medium	Light	None	None	Heavy
	Group 2, high K_2O				
	376	414	412	399	409
SiO_2	44.71	45.71	44.71	43.41	42.41
K_2O	6.43	6.43	6.43	6.43	6.43
Na_2O	2.00	2.00	2.00	2.00	2.00
CaO	1.00		1.00	1.00	1.00
PbO	45.70	44.89	43.89	45.00	45.00
As_2O_3	0.16	0.16	0.16	0.16	0.16
ZnO		0.81	1.81	2.00	3.00
Quality	Fair	Almost good	Fair	Good	Good
Fog	None	None	None	None	Medium

Group 1 is composed of glasses with low potassium and high sodium content. An increase up to 3% of zinc did not improve the quality to any extent. Any good effect due to zinc would be counteracted by the alumina in Nos. 440 and 436; but as the last member (No. 404) was poor evidently zinc will not give good glass with this alkali proportion. In Group 2 with high potassium and low sodium, much better glass was obtained and the presence of zinc seemed to improve the quality. The last two members containing 2 and 3% were quite good.

In Group 1 all of the glasses, except the ones containing alumina, fogged and this shows that addition of zinc will not overcome this defect in a poorly proportioned glass. In Group 2 the base glass does not fog and with zinc increasing up to 2% no tendency to fog is noticed. With the extreme member containing 3% zinc, the tests showed medium fog in some of the test pieces so it is possible that a too high zinc content would tend to cause this.

(I) Use of Calcium Although a number of melts were made with and without calcium it is hard to draw definite conclusions as to its effect on either quality or fog. Below are listed 4 glasses which give some information:

TABLE X

	Group 1		Group 2	
	396	376	371	368
SiO_2	44.71	44.71	44.89	44.80
K_2O	6.43	6.43	6.15	6.15
Na_2O	3.00	2.00	4.00	4.00
CaO		1.00		1.60
PbO	45.70	45.70	44.53	43.27
As_2O_3	0.16	0.16	0.45	0.18
Quality	Good	Fair	Good	Good
Fog	None	None	Light	Light

Group 1 is a case where the substitution of 1% of calcium for sodium gave a poorer quality of glass. In a number of cases this has been found to be true. The addition of calcium to other flint glasses has given a poor boil and poorer quality of glass. In Group 2 the calcium replaces lead so as to maintain the index. The quality of both glasses was about the same.

In Group 1 neither glass fogged, showing that calcium does not cause this defect when used in small amounts. In Group 2 both members showed light fog, showing that calcium has little tendency to prevent fog. Apparently this material is fairly neutral as far as fog is concerned.

(J) Potassium Content Eight glasses are listed showing an increase of potassium from 2.63 to 9.1%.

TABLE XI

	304	435	393	368	371	376	401	441
SiO_2	46.89	46.20	46.20	44.80	44.89	44.71	44.70	45.60
K_2O	2.63	5.00	5.50	6.15	6.15	6.43	7.00	9.10
Na_2O	4.70	3.50	3.00	4.00	3.99	2.00	3.00	
CaO	1.61			1.60		1.00		
PbO	44.02	45.14	45.14	43.27	44.53	45.70	45.14	44.10
As_2O_3	0.16	0.16	0.16	0.18	0.45	0.16	0.16	0.30
B_2O_3								0.85
Quality	Fair	Poor	Good	Good	Good	Fair	Good	Fair
Fog	Medium	None	None	Medium	Medium	None	Medium	Light

As the potassium increased the quality of the glass became better and the intermediate glasses Nos. 393, 368, and 371 were probably the best of the entire series, although No. 401 was also good. The extreme member, number 441, containing no sodium did not seem to give as good quality as when a certain amount of sodium is used. As high as 4% sodium gave a good glass when the potassium was about 6%. There is a tendency to fog with the higher per cents of potassium but in conjunction with this the sodium must be low. With more than 3.50% sodium the glasses fogged. In one case, No. 401, the glass fogged with 3% sodium. This apparently was due to the higher potassium content of this glass, as the last member, No. 441, also showed some fog with no sodium present. We may conclude then that the potassium content should not be above 6.5% and that the sodium content should not be over 3% and not under about 2% to obtain a glass which will have little tendency to fog. Of course these limits may be extended in certain cases.

(K) Use of Antimony No conclusive information was obtained upon this subject. Two examples of the use of antimony are given below:

TABLE XII

	Group 1		Group 2	
	376	427	304	384
SiO_2	44.71	46.20	46.89	44.88
K_2O	6.43	6.65	2.63	2.63
Na_2O	2.00	2.07	4.70	4.70
CaO	1.00	1.04	1.61	0.50
PbO	45.70	43.89	44.02	44.02
Sb_2O_3		0.17		1.11
As_2O_3	0.16		0.16	0.16
Quality	Fair	Poor	Fair	Fair
Fog	None	Light	Medium	Medium

In Group 1 the two glasses are the same except for antimony being substituted for arsenic and a change in the lead content to correct the index of refraction. In this case the quality of the antimony glass was not as good as that obtained with arsenic. In Group 2 antimony is substituted for lime without any improvement in quality. It is hard to judge effects that are not large in experimental melts of this kind. It is not certain, however, that antimony would necessarily give a poorer glass than arsenic.

In Group 1 the use of antimony apparently increased the fog. In Group 2 both glasses showed a medium fog and evidently antimony does very little good in this type of glass and there is no advantage in using it.

(L) Glass Based on Analysis of French Flint Number 383 was based upon our analysis of French flint glass. The resulting glass showed a heavy fog. This is not surprising when the composition is examined. The potassium is 2.26%, the sodium is 3.14%. Shipments of this glass showed considerable fog when used commercially and some had to be entirely rejected because of excessive loss due to fog. The complete analysis is given as composition No. 1 under the head of "Composition of Flint Glass."

(M) Conclusions In Table XIII are listed the glasses which were reported as not fogging. These are divided into three groups and they will give a fair idea of the limits of composition of glasses giving good results.

TABLE XIII

MELTS WHICH DID NOT FOG

	Group 1						
	465	406	395	414	376	412	399
SiO_2	46.11	46.20	45.71	45.71	44.71	44.71	43.41
K_2O	6.48	6.64	6.43	6.43	6.43	6.43	6.43
Na_2O	2.02	2.07	2.00	2.00	2.00	2.00	2.00
CaO		1.04			1.00	1.00	1.00
PbO	44.41	43.89	45.70	44.89	45.70	43.89	45.00
ZnO	0.82			0.81		1.81	2.00
As_2O_3	0.16	0.16	0.16	0.16	0.16	0.16	0.16

	Group 2					Group 3		
	396	377	393	435	380	440	437	439
SiO_2	44.71	44.00	46.20	46.20	46.28	44.25	44.25	42.25
K_2O	6.43	6.43	5.50	5.00	2.63	2.63	2.63	2.63
Na_2O	3.00	3.00	3.00	3.50	4.70	4.70	4.70	4.70
CaO		1.50			0.50	0.50	0.50	
PbO	45.70	44.91	45.14	45.14	44.02	44.65	44.65	44.65
ZnO						2.00		
As_2O_3	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Al_2O_3					1.11	1.11	1.11	1.11
B_2O_3							2.00	4.00

Groups 1 and 2 contain the practical glasses of good quality. It is hard to differentiate between them to any extent as only one experimental melt was made of each composition. Two of the batches have been used commercially with good results. The glasses in group No. 3 depend upon alumina to prevent fog and the boil of the glass during melting is not good. The quality would be poorer and hardly commercial. The proportion of constituents required for good glasses is quite definite. Potassium is relatively high while sodium is not over 4%. The silica may vary considerably. A small amount of calcium does no harm and zinc may be used without causing trouble.

(7) Fused Bifocal Lenses Using Colored Crown Glass

It is sometimes desirable to fuse a flint glass segment on a major lens made from colored glass. The principles involved are the same. Correction must be made for the effect of the coloring oxides used on the various properties of the glass.

The color from cobalt is so intense that little or no correction is necessary. The same is true with carbon ambers. Crookes glass required the normal amount of alkali but less lime is needed to obtain the correct index of refraction. When large amounts of iron are used as in Fieuzal and Smoke glasses, less lime is needed to obtain the required index of refraction, but little change in the alkali is necessary. Each plant develops colors depending upon the local needs so no detail of composition is given here.

(8) Colorless Fused Bifocal Lenses

In all fused bifocal lenses made from the crown and flint glasses just described there is a defect inherent in the glass itself due to its optical properties. This is a color fringe, more or less disturbing to the wearer of eye glasses, due to the difference in the mean dispersion of the two glasses. The same defect is paralleled in a poorly corrected photographic lens. The optical properties of the two glasses are given below. The partial dispersions are relatively unimportant and are not given.

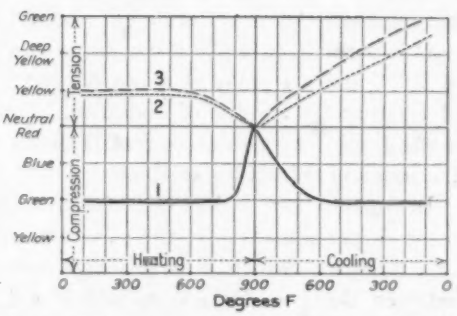

FIG. 6.—Color or strain in major lens; colorless bifocal.

TABLE XIV

	N_D	ν
Crown glass (major lens)	1.5230	59.0
Flint glass (segment)	1.616	36.5

Difference in magnification for far and near vision is obtained by the difference in index of refraction of the two glasses, while the color fringe spoken of is due to the difference in the mean dispersion or ν of the two glasses. Color fringe due to this cause could be eliminated if the two glasses had the same mean dispersion.

The importance of this idea is brought out in patent applications. U. S. patent 1,489,630, 1924, T. B. Drescher to Bausch & Lomb Optical Company, covers the idea. It is much easier, however, to make a patent application than it is to make the glass. The Drescher patent calls for a

bifocal composed of a segment and countersink (major lens), both the major portion and the segment being formed of a glass having the same dispersion but different indexes of refraction. Other patents by Brown, Tillyer, Fennell, and Bugbee bear on the subject. The problem of making two glasses with the required indexes of refraction and the same mean despersion was given to the Glass Research Department for solution. The field of possible optical glasses has been covered by the writer in a previous paper.[13] Referring to the chart in this paper giving the fields for various types of glass in their relation to the refraction index for the D line and the mean dispersion, we find that the mean dispersion must lie between 49 and 60 or thereabout.[14]

It is possible to make a crown glass or soda-lime glass with an index of refraction of 1.523 and a ν value of about 60 and a light flint glass with an index of 1.5230 and a ν value of about 49. Intermediates of these two may be made, giving any ν value desired between the limits given and maintaining the index of refraction at about 1.5230.

It is possible to make a barium crown glass with an index of refraction of 1.616 and a ν value of about 60 and a baryta-flint glass with an index of 1.616 and a ν value of about 49. Intermediates of these two may be made giving any ν value desired between the limits given and maintaining the index of refraction at about 1.616.

In manufacture it has been found that it is not necessary to have the mean dispersions exactly the same in both major lens and segment to obtain a bifocal which is practically colorless. The amount of difference between the two dispersions which will still give the result desired depends upon the curves used on the lenses. The higher the "addition" of the lens, or the stronger the curve, the closer they must agree in dispersion not to give color.

To satisfy these new requirements a barium or baryta flint glass must replace the flint glass used in the segment and the crown for the major portion of the lens also had to be changed. When trials were made with normal commercial glasses an entirely new set of defects developed. The fog defect did not appear as a serious one, although crystallization in one form or another was encountered in some of the glasses. A satisfactory quality of glass, free from bubbles and striae, is very difficult to obtain especially with the barium glass segment. Special glass pots are necessary to melt the barium glass. Surface tarnish or weathering appeared on the barium glass and the softening temperature of the segment was higher than that of the major portion, resulting in distortion of the curve between the lenses. The problem was divided into the following heads:

[13] "Twenty-Three Types of Optical Glass," *Jour. Amer. Ceram. Soc.*, 3, 404 (1920).

[14] See also "Classification and Nomenclature of Optical Glass," by Geo. W. Morey, *Jour. Opt. Soc. of Amer.* (July, 1920).

(A) Increase the softening temperature of the crown glass.
(B) Decrease the softening temperature of the barium glass.
(C) Change the barium glass composition to prevent surface tarnishing.
(D) Obtaining a barium glass free from bubbles.

These four problems in addition to the control of optical properties and coefficient of expansion made the research a rather complicated one.

The relative softening point of segment and major lens is very important. Some effort was made to reverse the order and fuse the soft major lens to the hard segment but manufacturing difficulties prevented its success. U. S. Patent 1,637,021 (1927), F. Fraser to American Optical Company, covers this idea. It would be very difficult to complete the fusion without distortion of the lens as a whole.

(A) Increase in Softening Temperature of Crown Glass

The softening temperature was determined by heating a glass rod approximately 1 by 3 mm. in cross-section and projecting 7.5 cm. in a horizontal position from a support in an electric furnace. The softening temperature is that at which the glass rod will start to bend under its own weight. The temperature of the furnace was increased at about 100°F per hour as the softening temperature was approached.

A rather extended series of tests showed that a glass whose alkali content was potassium and not sodium would give a considerably higher softening point. It was found that this raising of the softening point will allow fusion with baryta-flint and barium glass without distortion in cases when the regular soda-lime crown glass will give distortion. The normal baryta-flint or barium glass, however, had to be softened to obtain the desired result. The experiments using potassium were extended to cover many glasses having an index of refraction within the limits of 1.50 and 1.54 with a mean dispersion of 50 to 61 and the principle involved was made the subject of a patent application.

Two examples of the action of potassium in hardening the crown glass for this use are given for illustration:

TABLE XV

	1		2	
SiO_2	71.76	71.76	68.87	68.87
Na_2O	15.42	0.89	15.52	0.51
K_2O		14.53		15.01
CaO	10.05	10.05	6.60	6.60
PbO			7.12	7.12
ZnO			0.92	0.92
B_2O_3	0.26	0.26	0.25	0.25
Sb_2O_3	2.01	2.01	0.71	0.71
Softening temperature	1045°F	1175°F	965°F	1110°F
Approx. index	1.523		1.523	
Approx. dispersion	58		55	

In Example 1 the softening temperature is raised 130°F and in Example 2 it is raised 145°F by the use of potassium oxide.

(B) Decrease of Softening Temperature of Barium Glass

A survey of the glasses having the required index of refraction and mean dispersion showed that the softening temperature was 120 to 250°F above that of the corresponding crown glasses and fusion was impossible without distortion of the curve between the glasses.

Glass	Softening temperature	Glass	Softening temperature
A	1160°F	B	1220°F
A′	920	B′	1100
Difference	240°F	Difference	120°F

A′-B′ were soda glasses made before the idea of substituting potassium was introduced.

This high softening point was not confined to glasses made in the Bausch and Lomb Glass Plant. Several foreign glasses were tested as follows:

TABLE XVI

Glass	Index	Mean dispersion	Softening temperature
Schott	1.6090	58.9	1220°F
"	1.6140	56.4	1230
Chance Bros.	1.6126	56.7	1200
Sendlinger	1.6139	56.4	1230

All of these temperatures are too high to allow successful fusion.

A series of experimental melts brought out the fact that in baryta-flint and barium glasses the addition of lithium oxide or the substitution of lithium oxide for one of the constituents of the glass will have a marked effect upon its softening temperature and will allow the desired fusion to be made with a crown glass without causing distortion of the curves between the two pieces of glass. The idea was made the basis of a patent application.

To illustrate the action of lithium oxide in reducing the softening temperature the following series is given. Li_2O was substituted for K_2O.

TABLE XVII

Glass	Lithium oxide (%)	Softening temperature (°F)
E-1028	0.00	1150
9-6-1	1.18	1040
9-6-2	2.07	1020
9-3-1	2.96	1000
9-3-2	4.45	975
9-3-3	8.63	945

In many cases the lithium oxide, as substituted for potassium, has a tendency to increase the index of refraction and this is a considerable aid in obtaining the index of refraction of 1.616 with a high silica content. The need of a relatively high silica content will be given later.

The lithium oxide, as substituted for potassium, gives a glass of higher coefficient of expansion and makes it necessary to lower the total alkali content in order to match the major lens in expansion. This aids somewhat in obtaining a higher index of refraction as lead or barium may be substituted for the alkali taken out. Also a more stable glass, less liable to tarnish, is obtained with lower alkali.

The following are three typical glass compositions which give the amount of softening required and will allow fusion with crown glass of the same mean dispersion. The crown glass has its softening temperature raised by the use of potassium and its coefficient of expansion controlled.

TABLE XVIII

Glass	E-1157	E-1259	E-1265
SiO_2	44.46	38.57	32.00
Li_2O	4.50	1.50	1.50
K_2O	5.05	1.17	2.00
CaO	1.55	5.22	
BaO	30.29	38.16	44.00
PbO	11.12	0.93	1.30
ZnO		7.94	1.92
B_2O_3	1.00	6.75	16.00
As_2O_3	0.52	0.73	0.50
Sb_2O_3	1.51	1.03	0.78
	100.00	100.00	100.00
Index of refraction	1.6186	1.6191	1.6094
Mean dispersion	49.4	55.2	58.2
Softening temperature	980°F	1100°F	1100°F

If a barium glass is to have a high index of refraction, that is, as high as 1.60 to 1.616, its composition cannot be varied greatly. The high index is due, primarily, to barium oxide but is aided by the lead oxide, calcium oxide, and antimony oxide present. The total of these materials must be over 40% to obtain the index required. The lead oxide helps to control the dispersion. The calcium is used to reduce the total amount of barium and the antimony oxide is used to aid in clearing the glass of fine bubbles.

The stability of the glass depends upon the silica content and it would be desirable to have it as high as 44% if possible. In two of the examples given it is not possible to put in as much as 44% silica. Silica also helps to control the dispersion.

Boron oxide controls the dispersion primarily. In the examples given, E-1157 with a dispersion of 49.4, the boron oxide is only 1%. E-1259 with a dispersion of 55.2 contains 6.75% while E-1265 with a dispersion of 58.2 contains 16%. In general, the total alkali, potassium, and lithium increases with the increase of silica. Zinc oxide also acts as a flux and may in part take the place of the alkali. It is difficult to give good reasons for the exact amount of each material used. Chance plays a certain part in the development of these glasses.

While lithium is an alkali along with sodium and potassium it is seldom

used in glassmaking. Lithium oxide costs about $1.50 a pound as compared to 2 cents for soda and 6 cents for potassium. A higher percentage of sodium or potassium will give the barium glass a lower softening temperature but the use of more sodium or potassium will increase the coefficient of expansion beyond any hope of matching, will make it more difficult to obtain the required optical properties, and decrease the stability of the glass. An example of this is a sample of glass obtained from LePersonne (France) having an index of refraction of 1.6144 and a dispersion of 54.6. The softening temperature is 1090°F or much lower than barium glass tested outside of those containing lithium oxide. The coefficient of expansion, however, is very high and the glass weathers or tarnishes very easily. In other words, the glass is not resistant enough for use in bifocal lenses. The use of lithium oxide allows the glassmaker to make a more resistant glass because less is required to obtain any desired softening temperature than if other alkalis were used.

Potassium is less active than sodium in lowering the softening temperature. The substitution of 7% sodium for 7% potassium lowered the softening temperature of a barium glass 80°F, while the substitution of 4.45% lithium for an equal amount of potassium lowered the softening temperature 175°F.

Titanium oxide does not lower the softening temperature of these barium glasses. The same is true of an excess of antimony, zinc, cerium, boron oxide, calcium, magnesium, alumina, or calcium phosphate. Lead oxide cannot be used to soften the glass as this would lower the mean dispersion too much.

(C) Change in Barium Glass Composition to Prevent Surface Tarnishing

Satisfactory fused bifocal lenses were made free from the defects already discussed but when they were exposed to weather they showed surface tarnish. As spectacle lenses are worn under all sorts of weather conditions this caused the rejection of the finished lens. A survey and a series of tests showed that barium glasses obtained from various sources all showed this defect when exposed for thirty days on the roof of one of the buildings. This list included dense barium glass from Chance Bros., Sendlinger, LePersonne, Schott 1909 and 1923 glass, U. S. Bureau of Standards, and a number of Bausch and Lomb glasses. A fractured or polished surface would tarnish to the same degree. The degree of annealing had no effect on the amount of tarnishing. Attention was turned to the composition.

Tests showed that the addition of 5% alumina would not prevent tarnishing and the reduction of the alkali (sodium or potassium) to zero would not prevent it.

The barium-silica ratio was next studied. The barium content was

lowered, keeping the silica content as high as possible. Several melts are as shown in Tables XIX and XX.

Up to 13% CaO did not prevent tarnishing. With silica 44% or above and with barium about 30% a glass may be obtained which will show no tarnish. In a flint glass with an index of refraction of 1.69 the silica may be as low as 37% without tarnishing. It is possible that other combinations may be found which will give a good glass, but if the index

TABLE XIX

SILICA SERIES

Glass	E-945	E-948	E-961	E-956	E 942
SiO_2	39.0	41.0	43.0	44.0	46.0
K_2O	3.0	6.0	7.0	6.0	7.0
BaO	25.0	25.0	23.0	25.0	24.0
PbO	14.0	11.5	18.0	18.0	19.0
ZnO	3.3				2.8
B_2O_3	6.0	7.0	1.0	1.0	
As_2O_3	7.7	0.5	0.5	0.5	0.5
Sb_2O_3	1.0	1.0	1.0	1.0	0.7
CaO	8.0	8.0	6.5	4.5	
Tarnish	Yes	Yes	Slight	No	No
Index	1.6271	1.6111	1.6179	1.616	1.5993
Dispersion	48.1	50.0	45.6	(?)	45.5

The glass was not well annealed so the values for index and dispersion are approximate.

TABLE XX

BARIUM SERIES

Glass	E-983	E-987	E-968	E-975
SiO_2	37.0	37.0	43.0	43.0
K_2O	5.0	3.0	7.0	7.0
BaO		4.0	30.0	37.0
PbO	29.50	24.5	11.0	4.0
B_2O_3	16.0	16.0	1.0	
As_2O_3	0.5	0.5	0.5	0.5
Sb_2O_3	2.0	2.0	1.0	2.0
CaO	10.0	13.0	6.5	6.5
Tarnish	Yes	Yes	Slight	Yes
Index	1.6169	1.6191	1.6123	1.6063
Dispersion	43.9	46.0	48.8	52.0

The glass was not well annealed so the values for index and dispersion are approximate.

of refraction is kept about 1.611 very few other combinations are possible with the material used.

Conclusions (1) All the commercial barium glasses tested showed the defect of tarnishing. (2) Judging from the melts made, it is not possible to make many normal barium glasses which will not tarnish. (3) Alkali, alumina, lime, or boron oxide is not the cause of tarnishing. (4) While silica may be as low as 37% in a lead glass, a barium glass with 30% barium oxide must contain about 44% silica to prevent tarnishing. (5) If the barium content is as high as 37% it will tarnish with 44% silica.

(D) Obtaining a Barium Glass Free from Bubbles

The question of glass quality was not studied as a separate subject but was noted in conjunction with all experimental melts. Dense barium glasses free from bubbles are very rare. Commercial glasses now on the market all contain this defect to a greater or less extent. It seems to be largely chance which will give an occasional combination of really good quality. A complete discussion is beyond the purposes of this paper. Barium glasses with an index of refraction of 1.616 are among the most difficult to make, and freedom from bubbles does not depend upon composition alone. The pot in which the glass is melted, furnace operation and temperature, quality of raw material, etc., all must be considered. A few points in regard to composition have been established as being important.

Extensive experiments have shown that many glasses poor for bubbles will be decidedly improved by the addition of from 0.3 to 3.0% of antimony oxide. This idea is covered by U. S. Patent 1,513,923 (1924). Lithium also seems to improve the glass and its softening action allows a better evolution of bubbles. After the requirements of softness, coefficient of expansion, optical properties, and freedom from surface tarnishing are met, very little change in composition can be made to improve the quality. Satisfactory combinations have been obtained of fair quality. An example is as follows:

TABLE XXI

	Crown glass E-1332		Barium glass E-1255
SiO_2	67.26	SiO_2	38.57
Na_2O	1.55	Li_2O	1.00
K_2O	14.65	K_2O	1.67
CaO	6.11	BaO	36.16
PbO	6.95	PbO	0.93
ZnO	0.90	ZnO	7.94
B_2O_3	0.25	B_2O_3	6.75
Sb_2O_3	1.88	Sb_2O_3	1.02
As_2O_3	0.45	As_2O_3	0.73
		CaO	5.22
Index	1.5245	Index	1.6158
Dispersion	55.2	Dispersion	55.0

While theoretically a series of glasses should be possible with a mean dispersion varying from about 52 to 58, practically, limitations of quality and stability as well as softening temperature limit the field considerably. It is probable that the only satisfactory combinations will have a mean dispersion near 55.0.

(9) Thermal Expansion of Barium Glass

In the study of strain relations of the barium-crown combinations Sharp's drawing test, already referred to, gave a curve with glasses which matched. The flint glass-crown glass combination bends toward the crown glass,

while the barium glass-crown glass combination bends toward the barium. Calculated coefficient of expansions using the factors of Winkleman and Schott only helped in a general way. No direct comparison is possible. The strain relation of the barium glass-crown glass combination on reheating, being observed in polarized light, is given in Fig. 6.

A temperature of 930°F was required to relieve strain with this combination as compared to slightly under 900°F for the normal soda-lime glass. Curves 2 and 3 show more strain after the test than before, probably due to poor annealing or too rapid cooling. No. 1 curve returned to its original strained condition.

The thermal expansion of a normal barium glass, together with the softening temperature, as compared with the normal flint and crown glass is given in Fig. 4. The thermal expansion curve of the special crown with a high softening temperature due to potassium and of the special barium glass with a low softening temperature due to lithium, was not determined.

Bausch & Lomb Optical Company
Rochester, N. Y.

Ceramic Division
Department of Metallurgy
University of Toronto
Toronto, Ontario

Announcing
1929
Summer Meeting

The usual summer "plant tour" meeting of this Society will not be held this year.

The Board of Trustees thought it best that members of the Society should join in the plant trips arranged for the British Ceramists.

A preliminary partial itinerary is given in this number of the *Bulletin*.

This affords a larger and more informing opportunity than would a week alone with our own men.

The British ceramists are regular fellows, up-to-date plant executives, and technologists.

CERAMIC ABSTRACTS

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Abrasives

Progress in grinding gives better work and bigger profits. FRED B. JACOBS. *Abrasive Ind.*, **10** [2], 46 (1929). E.P.R.

Design grinding equipment to meet production demands. W. T. MONTAGUE. *Abrasive Ind.*, **10** [2], 48 (1929).—The progress made in the development of cylindrical broadcut, automatic grinding machines, machine lapping, and precision grinding methods is outlined. With present-day equipment, M. points out how it is possible to obtain high production and secure extreme accuracy with unskilled labor. E.P.R.

Heavy equipment a feature of 1928. ALLEN SEYMOUR. *Abrasive Ind.*, **10** [2], 50 (1929).—S. describes several types of comparatively heavy equipment introduced during 1928 for rough-grinding operations. Of particular interest is a segmental wheel designed to replace sandstones in the edge-tool and other industries, and a large manufactured pulp stone which is gradually replacing the natural variety. E.P.R.

Hydraulic control improved. F. W. PENSINGER. *Abrasive Ind.*, **10** [2], 53 (1929).—Several interesting developments in hydraulically operated precision grinders adapted to a number of production operations are described. It is interesting to note the remarks regarding dynamic balanced motors for grinding wheel drives. This is a step in the right direction as a grinding wheel cannot function correctly if its spindle is out of balance. The multiple-wheel grinder adapted for crank grinding is an interesting development. With this grinder it is possible to finish 2 pins, or 3 main bearings, at one setting of the work. E.P.R.

Rate of metal removal governed by grinding wheel speed. WILLIAM MACGREGOR. *Abrasive Ind.*, **10** [2], 58 (1929).—Improvements made by the Carborundum Co. in various types of abrasives, such as wheels for external and internal precision grinding, high-speed snagging, toolroom grinding, and cutlery grinding are described. Improvements made in coated abrasives, finishing compounds for lapping, and polishing grains are also outlined. E.P.R.

Progress in 1928. ANON. *Abrasive Ind.*, **10** [2], 59 (1929).—Improvements in grinding machines, grinding wheels, wheel-manufacturing methods, grinding processes, and the strengthening of engineering facilities to meet the ever-growing demands of the abrasive consuming trades are outstanding features in abrasive development during the past year. E.P.R.

Centerless grinding offers manufacturing economies. R. E. W. HARRISON. *Abrasive Ind.*, **10** [2], 62 (1929).—Some interesting centerless grinding operations performed on a production basis are described. These developments are interesting as they point graphically to the great strides made in centerless grinding. H. also describes operations performed on center-type machines wherein the grinder has taken the place of the lathe, promoting accuracy and expediting production. E.P.R.

Segmental vs. solid wheels. JOSEPH L. BALLASH. *Abrasive Ind.*, **10** [2], 64 (1929).—Within the past year the use of segemental wheels has increased to replace solid wheels of the cylinder type, particularly for surface grinding operations. E.P.R.

Exhibit abrasive tools on west coast. ANON. *Abrasive Ind.*, **10** [2], 64 (1929).—Abrasives and abrasive machinery played an important part in the Western Metal Congress and Western States Metal and Machinery Exhibition held in Los Angeles Jan. 14 to 18. The abrasive exhibits were attractive and created much favorable comment. E.P.R

Water supply. ANON. *Abrasive Ind.*, **10** [2], 65 (1929).—The water supply on a grinding machine should be plentiful, as it is necessary to keep the work as cool as possible. This applies particularly to cylindrical operations where ordinary sulphate of soda and water make a good grinding solution. Excellent results are obtained by em-

ploying special grinding compound made for the purpose. The compound should be mixed according to the maker's directions and passed to a settling tank after use. E.P.R.

New England man builds grinding machines for twenty-five years. ANON. *Abrasive Ind.*, **10** [2], 66 (1929). E.P.R.

Grinding large cylinder bores. H. H. MOORE. *Abrasive Ind.*, **10** [2], 69 (1929).—That the heavy-duty, planetary-type internal grinder is finding a permanent place in modern production schedules is graphically shown by illustrations. Formerly the large cylinders in question were finished by the uncertain and expensive process of boring. The grinding method offers a much higher degree of accuracy than is possible by the antiquated boring method and at the same time production costs are reduced materially. The American-built, heavy-duty, internal, planetary-type grinder is a triumph of the machine designer's art. E.P.R.

Abrasives finish cleaner parts. ANON. *Abrasive Ind.*, **10** [2], 71 (1929).—Great strides have been made in the introduction of electrically driven household equipment during the past decade. The object of this article is to illustrate and describe briefly some of the interesting abrasive operations performed daily at the plant of the Air-Way Electric Appliance Corp., Toledo, Ohio. E.P.R.

One hundred years of ax-making reveals interesting processes. HERBERT R. SIMONDS. *Abrasive Ind.*, **10** [2], 74 (1929). E.P.R.

Steel back, thick, abrasive disk. ANON. *Abrasive Ind.*, **10** [2], 85 (1929).—The problem of fastening abrasive circles to the steel disk wheel grinding machines has been given considerable attention during the past few years, and Charles H. Besly & Co., Chicago, recently devised a new arrangement. The new Besly disk is a grinding member consisting of a comparatively thin steel plate on which the abrasive is built. This steel back is bolted to the disk wheel of the disk grinder, and when the abrasive is worn off, the thin steel plate is returned to the maker and the abrasive is rebuilt on it. E.P.R.

Improved wheel truing tool. ANON. *Abrasive Ind.*, **10** [2], 86 (1929).—Greatly increased bearing life, higher operating accuracy, and a number of other advantages resulting in marked reductions in wheel-truing costs are claimed for a new dresser for cylindrical grinding machines recently introduced by the Ross Mfg. Co., Cleveland. E.P.R.

Grinder and buffer. ANON. *Abrasive Ind.*, **10** [2], 88 (1929).—The Hisey-Wolf Machine Co. recently introduced two new attachments for motor-driven grinding and buffing machines which it manufactures. One is a foot-treadle switch. The other attachment is an automatic electric light control. E.P.R.

Abrasives. V. L. EARDLEY-WILMOT. *Mineral Ind.*, **36**, 1–8 (1927).—The use of abrasives is becoming more and more general from the roughest of grinding to the finest of polishing. The materials used for abrasive purposes are many and are either "natural" or "manufactured" (artificial). Present source of corundum is the Zoutpansberg district of the Transvaal, South Africa, where it occurs as loose crystals in shallow alluvial deposits. The Transvaal production fell from 5996 short tons in 1926 to 1064 tons in 1927, the latter including 38 tons of grain corundum manufactured by the Transvaal Corundum Co., Ltd. The bulk of the world's supply of abrasive garnet comes from the vicinity of North River in the Adirondacks of N.Y. There was a slight decrease in the demand for garnet. The bulk of the garnet is used on paper and cloth and is particularly suitable for the sanding of hard woods. The majority of the natural grindstones produced in the U.S. comes from the sandstones of Ohio. The demand is mainly for the large stones of 6-ft. diameter with 1-ft. face which are used by some manufacturers of files, saws, and machine knives. Most of the small handstones are obtained from

various quarries operated by the Pike Mfg. Co. Their highest grade oilstones are obtained from white novaculites in the Ozark mountains of Arkansas, but their greatest production is from the schists and sandstones of Ind. and Ohio. Tripoli, amorphous silica, and rottenstone are very fine-grained powders known as "soft silicas." The two former when pure contain over 99% silica, are very similar, and under the microscope the grains are seen to have a rounded globular appearance. Tripoli which is derived from novaculite is mined by two companies on the Missouri-Oklahoma boundary line. About 30% of this material is used in buffing compositions, 60% for foundry partings, and the rest for filter blocks, fillers, and concrete admixture. Production increased slightly in 1927 and now amounts to about 1400 T. This is the only known deposit of true tripoli. Amorphous silica is derived from the siliceous or cherty limestones of Ill. and Tenn. The uses of this silica are somewhat similar to those of tripoli, but being a faster cutting material, its action in buffing is slightly different. Rottenstone, a fine-grained argillaceous material softer than the above, is produced by one company in Lycoming County, Pa. The manufactured abrasives, silicon carbide and aluminium oxide, are made by fusing certain ingredients such as coke, sand, sawdust, and salt and bauxite, coke, and iron borings in electric furnaces. E.P.R.

Progress in abrasives and abrasive engineering. V. L. Eardley-Wilmot. *Mineral Ind.*, **36**, 9–10 (1927).—During 1927 there appeared to be a slight decrease in the production of abrasives and abrasive products due to a temporary falling off of business, particularly in the manufacture of automobiles. The outstanding feature is the considerably increased use of organic binders, particularly Bakelite. The Bakelite bonded wheels can be operated at higher rates of speed than the vitrified wheels. This is now becoming a general type of wheel, the fine-grained abrasive being used for precision work and the coarse for snagging and rough work. They have now replaced the shellac and in many instances the ceramic bonded wheels and further developments of interest are expected. During the year progress has been made in the development of the equipment for multiple-diameter work and in the use of wide-faced and large-diameter wheels which require heavy machines as well as improvements in balancing equipment. There was also an increase in the use of disk grinding machines and machines with semi-automatic controls. E.P.R.

PATENTS

Mounting for abrasive wheels, etc. George W. Perks. U. S. 1,700,331, Jan. 29, 1929. A mounting for abrasive wheels, comprising a comparatively hard plate having preformed minute irregularities corresponding substantially to the minute irregularities characteristic of the surface of the wheel, and means to clamp the plate and wheel together so that the irregularities will mate and thereby securely retain the wheel in position when clamping pressure is applied.

Grinding threads. John Bath. U. S. 1,700,663, Jan. 29, 1929. The method of grinding threads which comprises taking a grinding cut with the work rotating in one direction, making a relative adjustment of parts between the work and the wheel equivalent to the back lash in the connections between the work and wheel, and then taking a second cut over the same threads with the direction of rotation of the work reversed and with the wheel moving axially along the work in a direction reversed to that of the first described cut, the direction of wheel feed reversed.

Grinding apparatus. Charles H. Schurr. U. S. 1,701,456, Feb. 5, 1929. The combination with a tool and a carriage on which a blank is mounted for engagement by the tool, of means for reciprocating the carriage including a driven shaft, a countershaft having connections with the driven shaft, a supplemental shaft, alternative connections between the counter and supplemental shafts having a clutch member arranged to engage either of the connections whereby the supplemental shaft may be driven

in either direction, a separate shaft having operative connection with the carriage, means operated by the separate shaft for shifting the clutch member, and means between the supplemental and separate shafts for driving the latter and cushioning the carriage in the reversal of movement thereof.

Precision thread grinding machine. FRANK O. HOAGLAND, PAUL M. MUELLER, AND AUGUST B. LINDSTROM. U. S. 1,701,675, Feb. 12, 1929. A screw-thread generating machine, comprising in combination a base, a work-supporting table thereon, means to rotate the table, a saddle movable on the base toward and from the table, a transversely movable slide on the saddle, a wheel spindle having a cutting wheel thereon rotatably mounted in the slide, a screw driven from the table rotation to move the saddle in one direction in timed relation to the table rotation, means to move the slide laterally during movement of the saddle, and driving means for the wheel spindle.

Grinding convoluted members. EINAR A. HANSON. U. S. 1,702,160, Feb. 12, 1929. In combination, an abrasive grinding wheel having spaced circumferential serrations of progressively decreasing size toward each end of the wheel, means for rotatably supporting the work, and means for moving the work and wheel, one relative to the other generally longitudinally of the work, the serrations at one end of the wheel being engageable with the work on relative movement between the work and the wheel in one direction and the serrations on the other end of the wheel being in engagement with the work when the relative movement is in the opposite direction.

Centerless grinding machines. V. A. B. HUGHES. Brit. 300,061, Dec. 31, 1928. A centerless grinding machine is adapted for producing accurately concentric but differently shaped surfaces on work pieces, such as the cylindrical body and tapered shank of a twist drill. The fluted body of a twist drill is produced in a centerless grinding machine in the usual manner and is then gripped in a split collet clamped by a hand-wheel within a work-holder having a cylindrical portion concentric with the collet. The holder is rotatably mounted on the usual work-support, by means of a half-bearing and a blade having an upper inclined surface engaging the cylindrical portion, a roller being pivotally mounted on the support and urged by a spring so as to force the portion against the regulating wheel. In operation, several work-holders are used in turn, one with a work piece mounted therein being placed on the support while the latter is raised by means of a hand-operated pinion engaging a rack on a controlling plunger to which the support is secured, the roller being moved to one side by a hand lever to allow admission of the holder. On lowering the support the holder is rotated by contact with the regulating wheel and a grinding wheel, which is staggered with regard to the regulating wheel, is fed in by its slide to cut the correct taper. The wheel may be dressed to the required taper or alternatively its slide may be inclined. When a work piece has been completed the holder is removed from the machine and replaced by another holder with a work piece to be operated upon while the previous holder is having its work piece renewed.

Grinding crank-shafts, etc. LANDIS TOOL CO. Brit. 300,190, Jan. 9, 1929. In a machine for grinding crank-shafts, etc., wherein the work is rotatably carried on a table slidable on a bed, and movable thereon through predetermined distances to present fresh portions of the work to the grinding wheel by means of a hydraulic motor and a pinion and rack, means are provided for cushioning the work table at the ends of its movement. The table carries a stop member which, during the movement of the table, contacts with one of the stops arranged at desired positions on a stop bar and thereby moves the bar axially until its motion is arrested by the contact of one of two collars screwing on the bar, with a sleeve in a bracket on the bed. The bar, through a lever, moves a piston in a cylinder, the exhaust of fluid therefrom being restricted by a ball valve in the piston head and thereby cushioning the movement of the table. The bar

is moved in the opposite direction to the movement of the table to an extent limited by one of the collars in order to allow of the cushioning as described above, by admission of fluid to the cylinder simultaneously with the manual operation; by means of a lever of a piston valve which admits fluid to the motor, the valve may be set in a mean position to allow manual operation of the table.

Grinding wheels, etc. CARBORUNDUM CO., LTD. Brit. 300,417, Jan. 9, 1929. An abrasive wheel or block, in which the abrasive member is held in a holder or chuck, has the grinding member somewhat thinner than the final thickness, a coating of sulphur or other cement being applied to the member in a mold of the same size as the holder, so that the member is located accurately in the holder. In the case of a segmental grinding wheel having a chuck comprising a base and outer and inner flanges, the segments are held against the outer flange by screws and plates. The segments have thereon a coating of cement so that the segments fit accurately against the flanges, and coatings also may be applied to the inner face and one end of the segments. The segments may be adjusted outwardly as the operative faces wear, by means of pressure applied through openings.

Grinding cylinders internally. J. SUNNEN. Brit. 300,648, Jan. 9, 1929. A device for grinding cylinders consists of a carrier having an axial bore and, in enlarged ends, transverse bores for the reception of bars, each pair of which carries a grinding element. The bars have formed thereon rack teeth which are engaged by a long pinion located in the bore and adapted to be rotated to adjust the radial position of the elements. The pinion is rotated slowly to allow of fine adjustment, by means of differential gearing carried at the upper end of the carrier, and consisting of a gear wheel secured to the carrier, a wheel secured to the pinion, and two internally toothed members formed in a member which is given a gyratory movement by an eccentric portion of an adjusting-wheel mounted on an extension of the pinion. The carrier is pivoted to a ring which is pivoted to a forked member adapted to be fixed to a driving motor. The elements comprise a pair of abrading elements held in position in channel section members by wooden strips and lead or aluminium strips and a pair of wooden elements held in position by strips.

Grinding cylinders. E. C. R. MARKS. Brit. 300,746, Jan. 16, 1929. A device for truing cylinder bores consists of a body having a central aperture and bosses to which are pivoted arms carrying abrasive members. The arms are pressed outward, to press the members against the cylinder wall, by cones on a shaft, the cones engaging complementary surfaces on the arms. The shaft has thereon a driving-member and carries a screwed sleeve which, on engagement with a head secured to the body, lifts the shaft and moves the arms outward; resilient pressure of the members against the cylinder wall may be obtained by unscrewing the sleeve from contact with the head and applying compression to a spring by means of a collar screwing on the sleeve.

Grinding razors, etc. SOC. D'ÉTUDES DE MACHINES À AFFUTER. Brit. 301,038, Jan. 16, 1929. A cutting-edge is formed on a razor or other blade by means of a grinding wheel, the blade having a previously formed bevel or face which is supported by a member right up to the edge, the grinding operation also removing a part of the support; by this means, no burr is formed on the blade edge. The grinding wheel is mounted on a carriage slidable on the machine bed and held up to a cam by a spring, rotation of the cam causing the wheel to approach, and to recede from the blade. The support is in the form of a cylinder and after each blade is treated is partially rotated to present a fresh surface to the new blade, by a weighted cord and a ratchet and pawl gear acting on the cylinder by worm gearing and actuated through a rod by a cam. The blade is mounted in a hinged holder carried by a leaf spring secured to a block, which is adjustably carried by pointed screws in a carrier adjustable in a guide on the machine

bed. The grinding wheel is mounted on its shaft between a shoulder and a pulley pressed up to the wheel by nuts.

Art

Colors in ceramics. E. W. ELY. *Bull. Amer. Ceram. Soc.*, **7** [10], 311–13 (1928); *Pottery Gaz.*, **54** [620], 298 (1929).—There is an increasing number of manufactured products in which color has become a pronounced factor. It is argued that (1) over-diversification of color is wasteful; (2) over-standardization stultifies and restricts; (3) simplification, intelligently and moderately applied, offers a middle ground or happy medium between these two extremes. E.J.V.

New colored glass. THEODORE LENCHNER. *Glass Ind.*, **10** [2], 49 (1929).—The most-talked-of subject at the recent glass show in Pittsburgh was a new colored glass shown by Kay & Fllinger, importers, New York. This glass is made in Czechoslovakia by the Moeser Co. and is called Alexandrite. It is colored by the use of a rare mineral, alexandrite (beryllium), which may be described as pure amethyst, much cleaner and more attractive than a color produced through the use of manganese. E.J.V.

Pre-wheel pottery. G. W. S. BREWER. *Pottery Gaz.*, **54** [620], 273 (1929).—B. describes archaeological discoveries in the neighborhood of Cleve Hill, near Cheltenham, which lead to the opinion that pottery was made in the paleolithic or Stone Age. By numerous samples and lantern slides, the tools are described which these Stone Age potters evidently used. There are stone mortars and pounders for the grinding of the clay, hearth stones which must have been employed in the firing, and shaped pieces of bone which were no doubt utilized in some of the primitive forms of decoration. Fragments of coarse pots also were found, always misshaped and badly fired, built up of coils or strips of clay, one upon the other. There seems little doubt, from the accumulation of evidence, that Cleve Hill was at one time a pottery settlement, in days before the potters' wheel was known. E.J.V.

Kabyle pottery. M. W. HILTON-SIMPSON. *Pottery Gaz.*, **54** [620], 293 (1929).—. Nearly every Shawia woman is capable of manufacturing such earthenware utensils as she requires for her own home, but at Beni Ferah, Algeria, where earth can be found that is peculiarly suitable to the potter, a large number of milk bowls, stew-pots, large flat dishes, etc., are made by the women for sale to the nomads of the desert in Biskra market and in the neighboring oases. No tools whatever are used in their manufacture, the Berber woman simply fashioning the moistened clay with her hands, attaining really remarkable symmetry of form in the simple models she adopts, leaving the pots, when made, to dry in the sun. When nearly dry, she polishes them with a snail-shell or a smooth round pebble, to produce an even surface inside and out, and proceeds, in many cases, to decorate them with criss-cross or lozenge patterns by means of a reddish earth, moistened and applied upon a blade of halfa grass doubled back to serve as a brush; and finally, when the sun has hardened the pots, they are baked outside the village, where no danger exists of setting fire to neighboring buildings. E.J.V.

The place of the ceramic designer. ARTHUR THEODORE FINCH. *Amer. Mag. Art.*, **20** [1], 29–35 (1929).—The National Museums, as the Metropolitan, trace the rise and fall of ceramic art, from the Egyptians who placed the manufacture of ceramics on a sound technical and artistic basis, through the Greek and Chinese development, to the decline following the Roman collapse; the rejuvenation in the Near East, Syria, and Persia; the recrudescence of its manufacture in Europe embracing the varied work of Italy and Spain, the Delft ware of Netherlands, the German stoneware and later hard porcelain, and the earthenwares and soft porcelains of 18th Century England to the evolving types of the U. S. potters. The designer must first adapt his talent to the mechanical processes of manufacture, and still produce pieces with distinctive appeal

through individuality. He may not involve a costly expenditure which will not bring in immediate return, keeping in mind the general public still wants the "last thing out," indifferent to or unable to judge design. The manufacturer's concern is its salability. The public revolts almost periodically against a certain phase of design expression, creating an opportunity for designers to rejuvenate, from the decadence, patterns with fundamentals of sound construction in form, color, and material effects applied to or in the clay body itself, declining to be carried away by a furore managed by partisan interests but not sound. To make, for novelty, a cup which belies its curved circular form, is not aesthetically satisfying or the best means of expressing clay material. The influence of the organized German Werkbund is a marked improvement in design. The notion is foolish that the latest out is best, or that there is anything artistic in imitating weaknesses of old wares which were incidental to limited knowledge. Fortunately the lesson is being learned that handles to dishes should harmonize with the structure and fulfill the purpose of being picked up easily. E.B.H.

Picturesque fireplaces and practical chimneys. H. A. SIMONS. *Arts and Dec.*, **30** [4], 48–49 (1929).—The function of the chimney is not only to carry off the smoke and gas, but also to supply the heater with oxygen required for combustion. Fire loss, excessive coal consumption, and inefficiency of operation suggest investigation into the construction of chimneys. In this article ten points cover the chief sources from which the major defects of chimneys and fireplaces arise. A Spanish fireplace of Talavera tiles and a carved Gothic plaster fireplace are illustrated. E.B.H.

Tile borders make decorative doorways. CHARLES A. BYERS. *Arts and Dec.*, **30** [4], 58–59 (1929).—Tiles used as doorway borders, most effective with plain stucco in Mediterranean architecture, are described and illustrated. E.B.H.

Pottery from the Mimbres Valley. ANON. *Art and Arch.*, **27** [1], 47 (1929).—Sixty pottery bowls were discovered in the Mimbres Valley in N. Mex. by an expedition from the Minneapolis Institute of Arts. The designs, geometric and naturalistic, are remarkable and varied, showing a perfection beyond the development of that race in any other line. Broken in the bottom of nearly every bowl was a hole for the escape of the spirit of the bowl to accompany the spirit of the dead over whose head the bowl was found. E.B.H.

The world's oldest stained glass windows. FRANZ L. MULLER. *Art and Arch.*, **27** [1], 41–45 (1929).—To this day it has remained a secret why the use of glass windows for living quarters already known to the Romans did not spread into Germany, France, or England until far into the Middle Ages. The oldest reference to stained glass is found in Tegernsee, Bavaria, where it was used in a church about 1000 A.D. The chief charm is not the usefulness of the windows but the solemn exalted mood created by the design and harmony of colors. In the cathedral of Augsburg are the world's oldest existing pieces of stained glass. Germany, the classic land of mysticism reached a particular perfection during the flourishing of glass painting. The psychological insight of the German master, Holbein, recognizing the possibilities as well as the limitations of both materials and schemes, gives the keynote of his success. He made the garments of his figures indicate and intensify the innermost feelings. E.B.H.

Nonlustered ware of Spain. CATHERINE MORAN. *Int. Studio*, **91** [378], 48–50 (1928).—From the early Christian era Spain has been famous for the making of decorated pottery, though glazed earthenware was probably carried there by the Arabs in the 8th Century. Hispano Moresque pottery may be divided into two classes: (1) the architectural variety using green and purple, and (2) the blue and yellow ware to which luster might be applied. In the 15th Century the new procedure "cuerda seca" was introduced. A mold of wood or metal was pressed on the unbaked tile throwing the edges of the pattern into relief. A mixture of grease and manganese which turned

black when baked, brushed on to this outline prevented the colors poured into the body of the design from intermixing. An Italian, Niculaso Francisco, introduced a process of painting designs on tiles enameled with the honey-colored medium so typical of Spanish tiling. "Puente del Arzobispo" employed an outline of grease and manganese filled in with pure enamels, an ingenious and animated effect being sometimes given by lines drawn to represent shadows, the whole covered with the honey-colored enamel. The expulsion of the Moriscos who did the bulk of the work caused the decline in the 17th Century. The renewal of the ceramic industry in Spain is a widespread and new activity in Europe and the exhibition in Barcelona next March will stimulate the art. Illustrated. E.B.H.

The collector. ANON. *Int. Studio*, **92** [380], 51 (1929).—Many outstanding French artists of the past century have been actively interested in ceramics, among them, Bracquemond, the Carrieres, Rodin, and Renoir. Paul Gauguin's son is a contemporary ceramist. Claude Renoir achieved distinction as a potter attaining after three years' effort an exquisite quality of glazing, showing a faintly pink surface. His work with its characteristic pastoral scenes may be seen at the Barnes Foundation at Merion, Pa., or in the Culin collection at the Brooklyn Museum. E.B.H.

Great names in the history of English glass. III. Robert Mansell. F. BUCKLEY. *Glass*, **5** [5], 199 (1928).—Robert Mansell is described as "the father of English glassmaking." He was instrumental in securing passage of the law which prohibited the use of wood fuel in glass manufacture and thus aided in suppression of the small, independent glassworkers who contributed nothing to the progress of English glass. The conditions under which Mansell trained his apprentices were favorable for the ultimate invention of British flint glass. Apart from Mansell's great services to the country in consolidating and improving the glass industry, and in teaching the English to make crystal glass with coal fuel and closed glass pots, he deserves recognition for having designed a form for drinking glasses which has survived to the present day. This is the glass with "rectangular straight-sided" bowl and short knopped stem. **IV. John Akerman.** *Ibid.*, [6], 247.—Akerman introduced into England the cutting and engraving (on the wheel) of fine crystal glass. According to Gerspach, in the middle of the 18th Century English cut glass had as completely superseded Bohemian cut glass in Continental markets as the latter had previously superseded the glassware of Venice. It is probable that English glasses were exported and used by foreign glass cutters for some time before glass-cutting was established in England. **V. Thomas Betts.** *Ibid.*, [7], 299.—Betts was one of the first Englishmen to gain fame as a glass cutter. **VI. Duke of Buckingham.** *Ibid.*, [8], 341.—English glassmaking was in a greatly weakened condition after the Restoration. The great Plague and Fire of London soon caused another upheaval. The Duke of Buckingham restored the making of fine glass in London as a settled trade. He was the owner of several important glassworks. **VII. Jerom Johnson.** *Ibid.*, [9], 392.—Johnson was the first to show that an Englishman could cut the English glass without foreign assistance. He was more or less self-taught. **VIII. Jackson.** *Ibid.*, [11], 488.—The family of Jackson is entitled to fame for establishing a business in the 17th Century which survives, at least in name, to the present day. For previous abstracts see *Ceram. Abs.*, **8** [3], 183 (1929). A.J.M.

Dutch exhibition in London. D. C. ROELL. *Illust. London News*, **173,** 1222–23 (1928).—Drawn from collections from every corner of the world, the exhibition of Dutch art at Burlington House promises to be the most important ever held. Delft and glassware figure in it as well as paintings, engravings, etchings, and silverware. H.H.S.

Chinese art exhibition in Berlin. ANON. *Illust. London News*, **174,** 40 (1929).—Organized by the East Asia Art Society in collaboration with the Prussian Academy,

the exhibition includes examples of ceramic art, bronzes, sculptures, and paintings ranging from the earliest age to the Manchu dynasty. Illustrated. H.H.S.

The Guelph treasure. ANON. *Illust. London News*, **174**, 45 (1929).—The Duke of Brunswick has ordered the famous Guelph collection to be sold intact. Eight photographs of enameled ornaments are shown. H.H.S.

Artwork quarterly's new editor. J.M.B. *Sunday Times*, Jan. 13, 1929.—The international quarterly, *Artwork*, published by J. M. Dent (2*s*. 6*d*. per number) is now edited by D. S. MacColl, who was formerly Keeper of the Wallace Collection. H.H.S.

Glass chipping glue. ANON. *Nat. Glass Budget*, **44** [39], 5 (1929).—The Russia Cement Co. specializes in the manufacture of the finest and best quality of chipping glue used extensively in the glass industry, both by firms decorating flat glass and those manufacturing table and other kinds of glassware. The firm has developed a special glue for the glass-chipping industry. It will do its work uniformly and efficiently. Many of the prominent glass manufacturing firms of this country and some in Canada have been and are using this special glass-chipping glue and have obtained splendid results for years past. E.P.R.

Trend to art moderne. ANON. *Pottery, Glass, and Brass Salesman*, **38** [22], 13 (1929).—The 1929 lines now on display show evidences of the influence of the new art on china and glassware. E.P.R.

Novelties for 1929. ANON. *Pottery, Glass, and Brass Salesman*, **38** [23], 17 (1929).—Beautiful and artistic merchandise as well as a range of popular-priced ware are being opened up every day for the inspection of buyers. E.P.R.

World-wide styles. ANON. *Pottery, Glass, and Brass Salesman*, **38** [25], 15 (1929).—American manufacturers and importers of ware from the Old World contribute styles that make 1929 lines attractive to buyers. E.P.R.

Compelling new lines. ANON. *Pottery, Glass, and Brass Salesman*, **38** [27], 23 (1929).—Distinctive decorative treatments are shown on 1929 glassware creations as well as on china and earthenware. Lines are now practically complete. E.P.R.

Russian exposition crafts of Soviet régime. ANON. *Pottery, Glass, and Brass Salesman*, **39** [1], 7 (1929).—Pottery by peasants and chinaware from State china works of interest to the trade were exhibited in the Art and Handicraft Exposition of Soviet Russia, during February at the Grand Central Palace, New York. Russia proves itself a possible competitor in the American market, for the gift ware trade particularly. E.P.R.

New medium for the decoration of china and glass. ANON. *Pottery, Glass, and Brass Salesman*, **39** [1], 20 (1929).—A material resembling silver or platinum is being used in ornamenting china and glass. This metallic decoration forms a most pleasing contrast to the white or ivory of the china body, and also to the colors in a decorative motif on both glass and china. The important feature of this substance is that it does not tarnish; it does not contain silver, but appears to be a mixture of gold and platinum. An all-platinum decoration is obviously too expensive to use on medium-priced tableware. The use of silver as a decoration has been tried repeatedly, but this has not met with complete success because of its being subject to tarnishing, with consequent loss of color and luster. This nontarnishable decoration can be obtained by the use of liquid, bright white gold. Precious metal decorations have always been popular, and this is a revival of a decoration of pleasing color, without the objectionable features of silver. E.P.R.

BOOKS

Etching of Glass. G. B. MILLER. Published by A. Hartleben. Berlin, 1928. $1.25. Reviewed in *Ceram. Ind.*, **12** [2], 226 (1929).—M.'s book, which is in German, covers

glass etching solutions for various glasses and the preparation of the acid baths. The etching of sheet glass and shaped ware for colored decoration is also discussed. Etching machines are given close attention and the mat surfacing of decorated glassware is treated from a practical standpoint. Treatment of ware intended for high-temperature decoration is discussed; in fact, practically every operation in the etching process is ably described. F.P.H.

Bristol Porcelain. FRANK HURLBUTT. The Medici Society, Ltd., London, 1928. Price 63*s*. Illustrated. H.H.S.

The Most Ancient East. V. G. CHILDE. 24 plates and 36 text illustrations. Routledge, Kegan Paul & Co., London, 1928. Price 15*s*.—The remarkable results of excavation in Mesopotamia, Egypt, and India are examined in detail, and shown to form a cultural unit about 3000 B.C., which prehistoric Europe largely absorbed and imitated. H.H.S.

PATENTS

Design for glass vase. REUBEN HALEY. U. S. 77,482, Jan. 15, 1929.

Design for plate or similar article. MATHEW A. HANSE. U. S. 77,484, Jan. 15, 1929.

Design for plate or similar article. URASABURO TOMITA. U. S. 77,630–31, Jan. 29, 1929.

Design for plate or similar article. CHARLES WEISS. U. S. 77,718, Feb. 12, 1929.

Design for glass vase or similar article. NICHOLAS KOPP. U. S. 77,556, Jan. 22, 1929.

Design for bottle. GEORGE N. MAS. U. S. 77,617–19, Jan. 29, 1929.

Design for bottle. ROBERT E. WALKER. U. S. 77,716, Feb. 12, 1929.

Design for tile. LOUIS G. MARMION. U. S. 77,649, Feb. 5, 1929.

Design for glass goblet. RAY C. COBEL. U. S. 77,673, Feb. 12, 1929.

Design for glass dish. REUBEN HALEY. U. S. 77,690, Feb. 12, 1929.

Design for covered dish or similar article. WALTER LINDLEY. U. S. 77,698, Feb. 12, 1929.

Decorating glass. J. T. AND J. FELL. Brit. 300,070, Dec. 31, 1928. Glass is decorated by placing it in contact with sprinkled floating cellulose colors (cellulose varnish and pigments) whereby the underside of the glass is patterned. The underside of the glass may be covered in parts with paper before contacting with the colors, the paper being afterward removed, and the plain glass thus revealed decorated by further contacting with the floating colors or by spraying or otherwise applying various colors. Tinsel, or other decorative material, or further colors may be placed on or between the cellulose colors if desired. The colors, etc., may be backed with a coating of india-rubber solution, wax paper, varnish, etc.

Cement, Lime, and Plaster

Effect of working gypsum mixes after stiffening. ANON. Bur. Stand., *Tech. News Bull.*, No. **140**, p. 173 (1928).—Calcined gypsum for certain purposes, such as in construction, must have a fairly quick set when mixed with water. Experiments have been made to determine how long gypsum may be worked without losing its strength due to partial setting. Tests made on cylinders after one-minute intervals from 2 to 7 minutes, inclusive, show values of 1070 to 710 lbs./sq. in., respectively, very little difference being indicated between the materials cast the first 4 minutes. The results indicate that no weakening of the set gypsum occurs as long as the paste can be molded. R.A.H.

Central mixing plants for the manufacture and sale of ready mixed concrete. NORMAN BEGGS. *Pit and Quarry*, **17** [8], 71–76 (1929).—The recent growth of central mix-

ing plants is an indication that this class of concrete is being favorably received in many localities and is a promise for the future. The article deals with the various considerations to be taken into account in establishing central mixing plants, selection of plant site, plant capacity, layout and construction of plant, transportation equipment, radius of operation, schedule of prices, quality and test of hauled cement, operating personnel, and capital required. R.G.E.

Expansion and contraction of Portland cement mortars. ANON. *Pit and Quarry*, **17** [8], 80 (1929).—This investigation was undertaken to ascertain the cause of crazing in mortars and stuccos and, if possible, to find a method or means of prevention. Preliminary investigations showed that controlled conditions of temperature and humidity were necessary, at least during the early hardening period. Mixtures have been made up under the following controlled conditions of temperature and humidity:

(1)	100°F	and	40 to 50%	humidity	
(2)	100	"	75 " 90	"	
(3)	85	"	40 " 50	"	
(4)	85	"	75 " 90	"	
(5)	70	"	20 " 30	"	
(6)	70	"	40 " 50	"	
(7)	70	"	80 " 90	"	

Inspections of the test pieces are being carried out at regular intervals but as yet no definite conclusions can be drawn. R.G.E.

Constitution of Portland cement. ANON. *Pit and Quarry*, **17** [8], 91 (1929).—In coöperation with the Portland Cement Assn., researches which may be divided into three main classes have been under way at the Bureau of Standards. They include: (1) studies on the constitution of Portland cement, (2) studies of the reaction of setting and hardening and the behavior of cement in use, (3) the influence of each component on the temperature required to burn the cement and on the cementing value of the product. The investigations on the constitution of Portland cement have shown the existence of two new compounds. These have the formulas $4CaO \cdot Al_2O_3 \cdot Fe_2O_3$ and $4CaO \cdot 2MgO \cdot Al_2O_3 \cdot Fe_2O_3$. $Ca(OH)_2$ and hydrated $3CaO \cdot Al_2O_3$ are the only crystalline products which have been identified by microscopic and X-ray examinations of cement compounds in water concentrations similar to those used in cement practice. Systematic studies are being carried out to determine the effect of each component upon the temperature required to produce cement and upon the cementing properties of the product. Starting with a base mixture of CaO, Al_2O_3, and SiO_2, it has been found that replacing a part of the CaO by MgO or a part of the Al_2O_3 by Fe_2O_3, or both, generally decreases the temperature required to burn the mixtures to complete combination. In general, the replacement of Al_2O_3 by Fe_2O_3 increases the strength of the cement; whereas, the replacement of CaO by MgO usually causes a slight decrease in the strength of the cements. The addition of MgO to the mixture usually affects the strengths very little. R.G.E.

Heat of reaction of Portland cement and water. ANON. *Pit and Quarry*, **17** [8], 93 (1929).—A study of the heat of reaction of Portland cement and water is in progress at the Bureau of Standards. An endeavor is being made to correlate the heat of reaction of cement with strength, fineness, time of set, ratio of SiO_2 to Al_2O_3, ratio of CaO to $SiO_2 + R_2O_3$, CaO, and volume changes. R.G.E.

Storing cements for demand. ANON. *Pit and Quarry*, **17** [8], 94–95(1929).—It often becomes necessary to store cement for prolonged periods of time under conditions and in places where climatic and commercial circumstances make this essential. A great many investigations on the action of storage of cement on its qualitative properties have been carried out and certain conclusions can be drawn from the results ob-

tained. Storing cement for varying periods of time has different effects on different cements. Cement which has not been properly stored can suffer much deterioration in quality after a comparatively short space of time. Cement can be stored for double the time in a good storage place as in a poor one without the strength of the cement being reduced. The investigations also showed that special grades of cement, *i.e.*, supercements and the like, are more unfavorably affected by storage than regular grades of Portland cement. R.G.E.

Effects of sulphates on Portland cement. THORVALDSON, VIGFUSSON, AND LAMOUR. *Pit and Quarry*, **17** [8], 95 (1929).—Sodium sulphate solutions react on only one of the constituents of Portland cement, tricalcium aluminate, whereas magnesium sulphate reacts with all three constituents. The reaction is more rapid, however, with the tricalcium aluminate. Mortars made from tricalcium silicate and from dicalcium silicate with the addition of tricalcium aluminate disintegrated rapidly in solutions of both sulphates. Steam treatment of the mortars increased the resistance to the sulphate solutions enormously. The action of the steam affected both lean and rich mortars equally, and appears to be chemical. R.G.E.

Adjustability of rapidly hardening concrete. B. MOHLMANN. *Pit and Quarry*, **17** [8], 95 (1929).—The age, kind of cement, consistency of batch, type of aggregate, mix curing, and size of test pieces are the factors considered with reference to the ability of concrete to adjust itself under test. The modulus of elasticity (E) was found to increase with the age of the specimen, and to be greater for rapidly hardening cements than for normal Portlands. Factors decreasing the value of E were increased water content, increased size of specimen, and increasing tension. Aggregate graded small and having a large percentage of voids also decreased the modulus. For like dimensions, E for compression is greater than E for tension. With increasing strength, the ratio of compression E to tension E decreased. In general, the factors increasing the strength of concrete also increased E. R.G.E.

Corrosive quality of slag in concrete. ANON. *Pit and Quarry*, **17** [8], 96 (1929).—The article contains abstracts from the symposium entitled "Is There Any Corrosive Quality in Slag?" published by the National Slag Assn. of Cleveland, Ohio. The question of the detrimental effect of slag on reinforcing steel in concrete persistently recurs in spite of the fact that there has never been a well-authenticated instance of such effect and the most prominent concrete authorities have expressed their decided belief that such action cannot and does not happen in well-made concrete. The conclusions of the symposium direct attention to several points which present a strong argument against the possibility of slag having any corrosive effect on reinforcing steel, provided the concrete is of sufficient density and thickness to prevent the passage of moisture, a condition which must be observed with all aggregates, regardless of their composition. R.G.E.

The burning process in automatic shaft kilns. HANS KÜHL. *Pit and Quarry*, **17** [8], 98 (1929).—The possible reactions taking place in the shaft kiln between carbon, oxygen, and carbon monoxide are discussed. A table shows the effect of temperature variation alone on the reaction of carbon and carbon dioxide to form carbon monoxide. At 750°C the dissociation of calcium carbonate used in cement manufacture is appreciable and as much as 75% of the carbonic acid can combine with the carboniferous fuel to form carbon monoxide. At higher temperatures this tendency will go almost to completion. Reduction occurs to a great extent throughout the clinker not because of occluded fuel dust, but because an excess of fuel in the kiln causes a formation of carbon monoxide which effects the reduction. The reaction of the fuel is a surface reaction, whether it takes place with carbon dioxide or air, and this accounts for the necessity of extremely fine grinding of the coal used. R.G.E.

Determination of grain size of cement. H. W. GONELL. *Pit and Quarry*, **17** [8], 98 (1929).—The article describes an air flotation method to determine grain size. The particles of the material to be examined are charged in at the top of a tube and a current of air under definite pressure is introduced at the bottom. A column is produced of various densities dependent upon the size of the grains. By standardizing according to known particle size, the grain size of cements can be quickly and accurately determined. Very large particles are determined by sifting. R.G.E.

Rate of hydration of dehydrated gypsum. P. P. BUDNIKOFF. *Kolloid Zeit.*, **46,** 95–96 (1928).—Natural and synthetic gypsum samples were finely ground and heated to 140°C in an electric oven until only traces of H_2O remained. Samples were placed in contact with H_2O vapor and liquid H_2O and the amount of combined H_2O determined by weighing, heating to 600°, and re-weighing. The samples in contact with liquid H_2O were washed several times with absolute alcohol, dried to constant weight at 70°, weighed, and heated to 600°. The increase in weight of dehydrated samples was rapid until the composition of the hemihydrate was reached when a retardation took place followed by another rapid increase until the composition of the dihydrate was attained. H.I.

Rate of dehydration of gypsum at different temperatures. P. P. BUDNIKOFF. *Kolloid Zeit.*, **46,** 97–98 (1928).—The rate of dehydration of both natural and synthetic gypsum was determined (1) at 40°C in a vacuum over phosphoric anhydride, (2) in a stream of dry air at 100°, and (3) in an electric oven at 140° and at 160°. The rate of dehydration of synthetic gypsum is lower than that of natural gypsum at the beginning of the process (except at 160° where the rate for both is the same). Later the curve (time vs. water loss) for the synthetic gypsum crosses that for the natural gypsum and thereafter remains higher. For 100° and 140° the curves of both types of gypsum show an inflection corresponding to a retardation of dehydration at the hemihydrate composition. H.I.

Modern cements. I. P. H. BATES. *Eng. News-Rec.*, **100** [23], 887–90 (1928).—A discussion of the present status of production and use of both standard Portland cements as well as the various other hydraulic cements now available. The latter are gradually but surely gaining a foothold in the producing and consuming industries. Physical and chemical properties of these cements are described. What is needed further in way of technical data is an extensive study of workability and volume changes. **II.** *Ibid.*, **100** [24], 932–34 (1928).—A general summary, pointing out the need of a concrete research program and the interdependency of the concrete and cement industries. L.A.P.

Strength specification concrete for street paving. F. A. HESS. *Eng. News-Rec.*, **100** [25], 968 (1929).—No additional cost and little of additional work are caused by unusual water-cement ratio requirements. L.A.P.

Comparative strength of concrete pavement cured by three methods. SEARCY C. SLACK. *Eng. News-Rec.*, **101** [5], 170 (1928).—Tests on roads cured by earth and water, surface application of calcium chloride, and surface application of sodium silicate show that the earth-cured concrete is the strongest. L.A.P.

Making cement of high quality. ANON. *Engineer*, **146** [3799], 487 (1928); *Rock Prod.*, **32** [3], 110 (1929).—An important industry may be established in Skye and on the peat bogs of the Aberdeenshire moors as a direct result of investigations which have been quietly made by experts into the properties of the skeletons of minute organisms. Diatomaceous earth is already being brought from Ireland for making cement of high quality. F.P.H.

Heat balance in rotary cement kilns. H. POOLEY, JR. *Rock Prod.*, **32** [2], 87 (1929); for abstract see *Ceram. Abs.*, **8** [2], 96 (1929). F.P.H.

Flue dust detrimental to Portland cement. ALTON J. BLANK. *Rock Prod.*, **32** [2], 48–50 (1929).—When flue dust is not added correctly to the raw mix, and where its presence in the kiln jeopardizes efficiency insofar as fuel economy and output are concerned, as well as causing a poor quality clinker to be manufactured, it may be considered as detrimental. F.P.H.

Calculation of Portland cement and clinker analyses. E. L. DRURY. *Rock. Prod.*, **32** [2], 57–58 (1929).—Good Portland cement can be made from raw materials which by analyses vary from the lowest to the highest permissible ratios, in some cases entirely out of the limits laid down by the earliest investigators. For a certain deposit, certain ratios will remain constant and cannot be changed unless a third material is incorporated. In a great many mill laboratories it is the common practice to use these ratios altogether for control work. Of the major points stressed by investigators, SiO_2/Al_2O_3, SiO_2/R_2O_3, Al_2O_3/Fe_2O_3, and $CaO/SiO_2 + R_2O_3$, the first three, in a uniform deposit will remain constant, and the fourth or lime ratio will vary. F.P.H.

Effect of fuel and air mixture in fusing cement clinker. H. H. BLAISE. *Rock Prod.*, **32** [3], 38–39 (1929).—The effect of load, speed, character of flame, drafts, hood pressure, preheated air, insulation, and the many other variables of a rotary kiln have been discussed often and without any discernible standard being established. It would seem that an improvement in color, strength, and grindability is accomplished by the use of an oxidizing flame, one that is evenly oxidizing throughout all burning points in the kiln. To have a good stack gas analysis is by no means proof that an oxidizing condition exists in the kiln. F.P.H.

Fuel economy in fusing Portland cement clinker. ROBERT D. PIKE. *Rock Prod.*, **32** [3], 40–46 (1929).—The present day rotary kiln for burning Portland cement clinker by the dry process has a thermal efficiency of 25%, but efficiencies twice as high as this should be obtainable. An efficient kiln using the dry process would consume about 600,000 B.t.u. per barrel of clinker less than the most efficient kiln using the wet process. This, combined with recent developments in dry grinding and sampling equipment, should give preference to the dry process. F.P.H.

The economics of Portland cement manufacture. W. H. PORTAS. *Rock Prod.*, **32** [3], 47–49 (1929).—Costs of the present uneconomic method in the standardized plant are no real guide to possible economy of production in a properly balanced plant. A plant can be said to be an economic producer if it has an overall efficiency of anywhere between 43 and 48%. This overall efficiency has to be raised to at least 80 or 90%. The rotary kiln, irrespective of its size, has at best only about 45 to 48% overall efficiency (clinker produced to fuel consumption), but in spite of this low efficiency the firing end of the rotary kiln has made practically no advance since it was originally designed. F.P.H.

New machine for testing lime hydrate. ANON. *Rock Prod.*, **32** [3], 123 (1929).—Stewart W. Jameson Co., Duluth, Minn., has announced a new trowel pull tester for testing lime under conditions identical to those found on the job. The machine is designed to take the place of the plasticimeter, which is the standard method of testing, but which it is claimed is not used by workmen on the job. F.P.H.

Variable hardening of Portland cement. H. KÜHL. *Tonind. Ztg.*, **52** [43], 870–75 (1928).—A similar study by Haegermann appears in *ibid.*, **52** [54], 1101–1102 (1928) and there are discussions in *ibid.*, **52** [54], 1110–13 (1928) and *Rock Prod.*, **32** [3], 110 (1929). A study of Kl storage shows the presence of "hidden forces which cause an increase or decrease in strength under different storage conditions." A bibliography on Kl storage is appended. The subject is of considerable theoretical interest, but is of no importance for the practical application of standard cements. F.P.H.

Influence of clay mixed with sand on the strength of Portland cement. W. F. JUFEREFF. *Tonind. Ztg.*, **52** [60], 1219–20 (1928).—On the basis of the results presented, clay mixed with sand tends to reduce the strength of cement-sand mixtures. F.P.H.

Process in burning cement in rotary kilns. E. RISSEL. *Tonind. Ztg.*, **52** [61], 1237–39 (1928); *Rock Prod.*, **32** [3], 110 (1929).—R. reviews extensively the work of E. S. and Wm. A. Ernst (*Rock Prod.*, **30** [3], 62–64 (1927)), H. Miller, and others. F.P.H.

Recent advances in Japanese Portland cement industry. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **31** [12], 285–87B (1928).—In the last five years, the Portland cement industry of Japan has made remarkable progress. The total capacity of mills is now estimated at about 26,000,000 barrels per year and it will become about 28,500,000 barrels in the next year. The manufacturing process is, in general, the dry process, but the wet process is being adopted by the newly established factories. The scale of the factory has doubled in these five years, as shown by the change of size of rotary kilns and tube type mills. The recovery of waste heat from the rotary kiln was first adopted in 1920, and there were, in 1927, 43 waste heat boilers with a total heating surface of 32,544 square meters, and 29 turbo-electric generators of total capacity 54,410 kw. corresponding to nearly 80% of the power used in the industry (S. Kasai's paper "Waste Heat Recovery in the Japanese Cement Industry" in Section P of the London Sectional Meeting of the World Power Conference, 1928). There are three associations connected with the industry. The first, the Japanese Portland Cement Engineers' Assn., was founded in 1900. On the recommendation of this association, the "Japanese Standard Specification for Portland Cement" was first issued in 1905 by the Government, and it was revised in 1913, 1919, and 1927. The latest specification was issued in April last year as "Japanese Engineering Standards JES 28." The quality of cement has been remarkably improved year by year. The eighteenth annual meeting of the association was held in Tokyo, Oct. 18 to 20, 1928. Many discussions and lectures were heard, the revision of the present specification, considering the remarkable progress in the quality of cement being one of the most important items. The second, the Japanese Portland Cement Assn., was organized in 1909. The association has been working on the publication of many reports, the steady supply of the standard sand for testing of cements, etc. The third is the Cement Makers' Federation, which is working on the estimation of capacity and of production of all factories. E.J.V.

Strength formula of cement mortars on curing ages. II. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind., Japan*, **31** [12], 301B (1928).—Continuing the studies on the increasing rate of strength of 1:3 cement mortars to curing ages, N. modified the parabolic equation between strength and curing ages to the linear equation (1) between strength and the logarithm of the curing age in days. (1) $S = A + B, \log d$. In this strength formula, S is the strength at d days, and A and B are constants of each cement. Applying many results of strength tests on many curing ages and calculating by the method least squares, constants of A and B were obtained for tensile and compressive strengths of each cement. These results were compared as in the following table and it was readily noted that there is a linear property between the value of B (2) and activity index (3) or silica modulus (4) in the chemical composition of cements.

(2) $B = (S\text{-}A) \log d$

(3) Activity index (A. I.) = SiO_2/Al_2O_3

(4) Silica modulus (S. M.) = $SiO_2/(Al_2O_3 + Fe_2O_3)$

ACTIVITY INDEX, SILICA MODULUS, AND CONSTANT *B*

Portland Cement		(A. I.)	(S. M.)	$B = (S - A)/\log d$ Tensile Strength	$B = (S - A)/\log d$ Compressive Strength
Japanese cements					
Low silica type	(1)	3.73	2.15	5.70	192
	(2)	3.83	2.10	6.07	176
	(3)	3.20	2.05	4.09	167
	(4)	4.06	2.15	6.64	196
	Mean	3.70	2.11	5.62	183
High silica type	(5)	5.19	2.95	7.71	206
	(6)	4.93	2.93	8.04	234
	(7)	5.13	2.73	9.25	279
	(8)	4.88	2.92	8.75	258
	Mean	5.03	2.89	8.44	244
Foreign cements	(10)	3.88	2.62	6.04	162
	(11)	3.74	2.71	5.27	138

For Part I see *Ceram. Abs.*, **8** [2], 94 (1929). E.J.V.

Gypsum. W. M. MYERS. *Mineral Ind.*, **36,** 278–83 (1927).—Due to a decrease of approximately 12% in valuation of new building operations in 1927 as compared with 1926, there was a smaller demand for gypsum building materials. Investigation of the suitability of gypsum-anhydrite mixtures for use as a retarder in the manufacture of Portland cement has been continued. This work, corroborated by industrial use has demonstrated the desirability of the use of such mixtures. E.P.R.

Talc and soapstone. PETER A. MCGURK. *Mineral Ind.*, **36,** 553–60 (1927).—Four years have been used in working out the possibility of using talc in concrete to make it waterproof, to facilitate its flowing into the mold, to yield a sharper mold, and to increase the tensile strength. E.P.R.

PATENTS

Production of Portland cement. HARVEY RANDOLPH DURBIN. U. S. 1,700,032, Jan. 22, 1929. The improved Portland cement having a tensile strength of at least 240 lbs. per sq. in. at 24 hrs. with a 1:3 sand mixture and which is prepared by burning Portland cement clinker comprising a large proportion of tricalcium silicate together with incompletely lime-saturated silicate, in intimate admixture with lime in amounts not more than that necessary to complete the saturation of the incompletely saturated silicate therewith, and grinding the resultant clinker to cement.

Production of Portland cement. HARVEY RANDOLPH DURBIN. U. S. 1,700,033, Jan. 22, 1929. An improved Portland cement having a tensile strength in excess of 300 lbs. per sq. in. at 24 hrs. in a 1:3 sand mix and which is prepared by incorporating silica, alumina and iron, with lime in amounts not more than that necessary to theoretically saturate the silica, alumina, and iron therewith, but considerably more lime than will combine with silica, alumina, and iron in one burning operation, burning the mass to incipient fusion, grinding the resultant product, re-burning the ground product to incipient fusion, and grinding the re-burned product to cement.

Rotary kiln for burning cement. ANON. Ger. 451,468; *Rock Prod.*, **32** [2], 87 (1929).—In the burning of cement the resulting heat losses are traced essentially to the waste gases leaving the kiln at high temperatures. The cross-section of the kiln is narrowed in such a way that the beginning of the narrowed zone, which is exposed to the entrance of the flames, is situated inside the calcining zone. Thus a rotary kiln with enlarged diameter is provided with a special narrowing between the sintering and calcining zone, in order to attain a high temperature in the sintering zone. In another well-known rotary kiln the congestion, due to the reduced diameter, takes place at the

border between the calcining and the preheating zone, so that the increase in temperature is greatest in the last part of the calcining zone, in respect to the direction of passage of the combustion gases. The congestion occurs then toward the beginning of this zone and in most cases does not enter at all into the lower part, in which the greatest heat requirement prevails, since here the fuel must be heated to 1100°C (2012°F). A complete calcination is therefore not possible. In another well-known rotary kiln a stream of air is introduced under high pressure above the sintering zone in such a way that it meets the flow of the fuel head on. Thereby a curtain of air is formed, which effects a retarding of the velocity of the heating gases. Due to the congestion at the border between the sintering and the calcining zone, which under the action of the air stream extends far into the sintering zone, a considerable excess of heat is produced, which is detrimental to the sintering. According to the invention described, the above-mentioned drawbacks are avoided in this way, that the congestion takes place within the calcining zone and preferably in its center, or at a somewhat greater distance from the sintering zone, so that this zone itself is not affected by the congestion. Therefore, on one hand no storage of excess heat, which would retard the process, takes place in the sintering zone, and on the other hand, the development of heat effected by the congestion is greatest in that part of the calcining zone which faces the entrance of the flames, in which prevails actually also the greatest heat requirement. F.P.H.

Operating rotary kiln plants with an attached cooling arrangement for heating combustion air. HARRY STEHMANN. Ger. 459,728; *Rock Prod.*, **32** [3], 110 (1929).—The invention is characterized (1) by the fact that the clinker is cooled in the cooling arrangement and during its passage through the cooling arrangement, by known means, through such intimate and repeated contact with the air that the air absorbs the entire clinker heat up to the limit of its heat-absorption capacity; (2) by insulation, etc., the passage of heat from the clinker to the exterior is prevented; (3) by providing the cooling drum with insulating brickwork and with special means for cooling the clinker and for revolving, *i.e.*, distributing or discharging the cooled clinker. Since very extraordinarily large volumes of heat are supplied to the rotary kiln with the highly heated air from the cooling drum, the fuel consumption in the rotary kiln itself drops about 30%. F.P.H.

Enamels

Enamel and its defects. A. MALINOVSZKY. *Jour. Amer. Ceram. Soc.*, **12** [3], 180–87 (1929).—The purpose of this paper is to bring out the remarkable characteristics of defects of ground coat, enamel, cast iron, molding sand, and sandblasting. The importance of mixing and smelting ground coat and enamel is pointed out. Analysis is made of the accumulations in the flues and stack of the smelter and of the volatilized oxides from the smelting enamel batch during the smelting operation. M. shows the loss from the calculated oxides of the material used and the oxides found by actual chemical analysis of the smelted batch; also the analyses of cast iron at surface and of interior. Illustrated.

Physical tests for vitreous enamels. C. J. KINZIE. *Jour. Amer. Ceram. Soc.*, **12** [3], 188–92 (1929).—Methods and apparatus for determining certain physical properties of vitreous enamels are described. These properties are as follows: (1) resistance to thermal shock of vitreous enamels applied to flat surfaces, (2) resistance to mechanical impact of vitreous enamels, (3) resistance of vitreous enamels to abrasion.

Choice of fuel in a modern enameling plant. W. D. THOMPSON. *Amer. Enameler*, **1** [10], 8–9 (1928); **1** [11], 6–8 (1929). M.E.M.

Development of cast iron for enameling. P. T. SEALEY. *Amer. Enameler*, **1** [10], 10–11 (1928).—A plea is made for research on the problem of a suitable enameling iron. M.E.M.

Sandblasting sheet iron. P. T. SEALEY. *Amer. Enameler*, **1** [11], 9–10 (1929).—S. recommends 25 lbs. air pressure with a large nozzle. The sheets should be blown off with high pressure air to insure removal of the dust, and should be covered with ground coat as soon as possible to prevent rusting. M.E.M.

Better castings for enameling. H. G. WOLFRAM AND W. G. BOGENSCHUTZ. *Amer. Enameler*, **1** [11], 13–15 (1929).—Many of the difficulties of cast-iron enameling are due to the iron base. Some castings which were giving trouble in enameling were found to have been poured very hot with no facing. A very tenacious burned-in sand scale appeared on these castings which was extremely difficult to remove by sandblasting. When these castings, apparently clean, were enameled, blistering occurred. This condition was overcome by using facing on the mold, a practice which has been universally condemned heretofore. Good results were obtained with plumbago, red talc, or carbon facing; poor results with charcoal. M.E.M.

Development of the continuous furnace. F. S. MARKERT. *Enamelist*, **6** [3], 8–14 (1928).—M. describes the Manion single end furnace. The chain conveyer makes a U-turn in the firing chamber, returning parallel to its incoming path. This construction has the advantage over the double end type of requiring less floor space, and having less heat loss. M.E.M.

Light colored ground coats for sheet iron. ANON. Bur. Stand., *Tech. News Bull.*, No. 140, 173–74 (1928).—Sixty-three light colored ground coat enamels have been prepared and tested. When these coats are applied to treated metal the composition of the enamel does not seem to be the most important factor in its adherence. The strength of the test specimens and the type of fracture obtained depend more upon the thermal expansivity of the enamel and the firing temperature. It appears that any ground-coat enamel now in use may be converted into a light colored one by simply eliminating the colored oxides and giving the metal a suitable treatment. A table giving the composition of the various enamels tried is included. R.A.H.

Antimony. K. C. LI. *Mineral Ind.*, **36**, 28–33 (1927).—In 1927 the world's production of antimony metal was approximately 21,000 T. of 2240 lbs., as compared with approximately 22,500 T. produced during the preceding year. China again was the most important producer, that country's output being about 90% of the world's supply for both 1926 and 1927. E.P.R.

Barium and strontium. CHARLES HARDY. *Mineral Ind.*, **36**, 56–60 (1927).—Barium and the compounds of barium are finding an increasing application in industry. The application of barium salts either as barium oxide, barium carbonate, or barium fluoride in the ceramic and glass industry is progressing, and especially the glass industry has shown recently considerably more interest in the use of barium oxide than heretofore, and it is anticipated that the increase in tonnage required for the glass industry alone will be several thousand tons a year. The Doty process for the extraction of practically pure barium sulphate from barytes is based on the molten sodium chloride dissolving and holding barium sulphate in solution to the exclusion of other minerals present. The barium sulphate is obtained by dissolving out the salt in water. Barium fluoride seems also to be one of the barium salts for which a large future may be anticipated, especially in the ceramic industry where barium and fluorine are desired. These elements are introduced into the batches at present in the form of barium carbonate and fluorspar, which ought to be replaced by barium fluoride, eliminating the use of fluorspar, which is rarely free from objectionable impurities. E.P.R.

Fluorspar. HUBERT W. DAVIS. *Mineral Ind.*, **36**, 206–10 (1927).—Salient features

of the fluorspar industry in 1927 are the decrease in domestic shipments, which are about 11% less than the average for the preceding five years. The imports of fluorspar into the U. S. in 1927 amounted to 71,515 short tons, valued at $595,185, and are the second largest ever produced. The consumption and stocks for the glass and enamel industries, although not covering all consumers, represent 117 companies, and are believed to be practically complete, as these companies include all the larger and probably most of the smaller consumers. E.P.R.

Surface conditions of castings as affected by core-sand mixtures. H. L. CAMPBELL. *Refract. Jour.*, **4** [40], 122–24 (1929).—In all cases where smooth surfaces are required on castings, the cores which form these surfaces must be smooth. The additions of bank sand or other finely divided materials to core-sand mixtures within reasonable proportions do not improve to any appreciable extent the smoothness of the surfaces of castings which are made in contact with these cores. E.P.R.

Natural raw materials for the enamel industry in Russia. L. N. MURAWLEFF AND P. N. GRIGORJEW. *Keram. Rund.*, **36**, 464–66 (1928).—Russian sources and possible supplies of feldspar, soda, boron compounds, fluorspar, cryolite, tin compounds, antimony compounds, saltpeter, and MnO_2 are enumerated. H.I.

Review of iron and steel literature for 1928. E. H. MCCLELLAND. *Blast Fur. Steel Plant*, **17** [1], 94–98 (1928).—This list constitutes the twelfth annual review of iron and steel literature compiled for *Blast Furnace and Steel Plant*. An attempt has been made to list the more important publications of 1928, together with certain publications dated 1927, but not available for inclusion in the list compiled near the end of that year. F.P.H.

Another competitor for ceramic tile. ANON. *Ceram. Ind.*, **12** [2], 215 (1929).—The new Chromite Co. will market a new product in the building field known as "chromite," a zinc-based enameled material designed to serve the purposes of tile in some uses and of wall paper in others. F.P.H.

Novel spray guns for decorating enamelware. ANON. *Ceram. Ind.*, **12** [2], 217 (1929).—The picture or pattern is either made with transfer designs or by aid of stencils. In order to make stencil or template decorations, spraying apparatus or air brushes are used. The various colors are sprayed upon the enamel by use of the spray gun which is operated with compressed air. Not only is colored enamel done with this spray gun, but it is also preferably used for finishing stoves, etc. F.P.H.

Enameling of sheet steel. I. WALTER SCHULZ. *Ceram. Ind.*, **12** [2], 218–21 (1929).—When high grade sheet or flat shapes are used, oil and grease may be removed by boiling in alkaline solution. While heat treatment is more expensive it gives better ware. Flat articles need remain in the water tank only 3 to 5 min., shapes with open rims about 10 to 20 min., and reamed ware or ware with large rims $^1/_2$ to 4 hrs. Acid collecting in seams and rims will ruin the ware if not thoroughly washed out. To enamel without ground coat it is advisable to sprinkle a little flowers of sulphur between the shapes to be annealed. This roughens the surface and permits better enamel adhesion. A similar effect is obtained by direct reducing fire with coke fuel. The inhibitor will furthermore prevent the rising of disagreeable and harmful fumes from the acid surface. The advantages of inhibitors are saving in time, steel, and acid, no disagreeable fumes, and no steel blisters. Disadvantages are: the inhibitor acid will not toughen the steel surface, and the sticking of enamel is not quite so good as on regularly pickled steel. This difference may be best noticed by applying enamels direct on steel without dark ground coats. All impurities rolled into the pores of the steel surface are very difficult to be removed by inhibitor acids, and may cause defective ware later. When heavy oils are used for drawing and are pressed into the pores of the steel, if rust has formed on the surface or a really high quality ware is desired, the scaling process

should be chosen. For gray and one coat enamels the burning off process is preferable because it does not leave iron chloride in the pores which may form blisters or copperheads. F.P.H.

Gas in the manufacture of cast-iron enamelware. J. B. NEALEY. *Gas Age-Rec.*, **62** [24], 829–30 (1928).—The enamelware plant of the Richmond Radiator Co. of Uniontown, Pa., is of brick and steel construction and the equipment is modern in every respect. The product is moved in a straight line. The melting furnaces, which are of brick construction and fired with gas, are heated to a temperature of 2250°F. The melting operation requires about three hours. The batch is withdrawn by opening a tap hole on the side of the melting furnace. The frit drier is heated by gas and makes about twelve revolutions per minute. F.P.H.

Gases extracted from iron-carbon alloys by vacuum melting. N. A. ZIEGLER. Institute of Metals, No. 57, *Tech. Pub.*, No. 168; *Min. and Met.*, **10** [266], 91 (1929).—This paper describes a series of experiments undertaken with the object of establishing a possible relationship between the carbon content and "gas content" of a series of iron-carbon alloys prepared in a high-frequency furnace open to the atmosphere. It has been found that the amount of gases evolved during the vacuum melting of these alloys increases very markedly with the original carbon content, being about equal to the volume of the metallic sample for the low-, and over 65 times for the high-carbon alloys, at normal temperature and pressure. In all cases CO is the predominating constituent of the gaseous mixture. It has been found that by proper adjustment of carbon and oxygen in the charge, the final product of the vacuum melting can be obtained substantially free from both. The commercial alloys investigated, as far as the composition of the gaseous mixture evolved is concerned, gave in general the same results as the laboratory samples. F.P.H.

The gamma-alpha transformation in pure iron. ALBERT SAUVEUR AND C. H. CHOU. Iron and Steel, No. 24, *Tech. Pub.*, No. 169; *Min. and Met.*, **10** [266], 93 (1929).—There seems to be little doubt but that the martensitic and the Widmanstattian types of structure are closely related. They both result from the deposition of the α phase along the crystallographic planes of austenite. The Widmanstattian structure in iron carbon alloys results from slow cooling through the transformation points, the α phase being finally converted into free α ferrite (in hypoeutectoid steel), while the γ phase after it has acquired eutectoid composition is converted into pearlite. The martensitic type of structure results from a rate of cooling so rapid that the transformations are delayed until a temperature of about 300°C is reached. Under these conditions, the transformation remains incomplete, the α phase possibly retaining some carbon in solution while rejecting carbon in the form of minute particles of cementite and being thereby converted into troostite. Some γ phase holding considerable carbon in solution remains undecomposed when it is known as "retained austenite." The aggregate of these two phases constitutes what is generally described as martensite. That the martensitic type of structure should be on a very much smaller scale than the Widmanstattian type is readily accounted for when it is remembered that it forms quickly at a low temperature, whereas the Widmanstattian type forms slowly at a high temperature. That the martensitic type should be very much harder than the Widmanstattian type is probably due to its much greater fineness, to the greater hardness of its constituents, austenite (now supercooled) and troosite (which may retain some carbon in supersaturated solution) vs. free ferrite and pearlite, the Widmanstattian constituents of hypoeutectoid steel. The presence of severe internal strains in martensitic steel may be also a contributory cause of the hardness. F.P.H.

BOOK

Impurities in Metals; Influence on Structure and Properties. COLIN J. SMITHELLS. John Wiley and Sons, 1928. 157 pp. $5. Reviewed in *Min. and Met.*, **10** [266], 103 (1929).—S. has collected the available information on the effects of small amounts of elements upon the structure, mechanical and electrical properties, and corrosion of metals, and presents it here in a systematic manner. The effect of constituents present in concentrations below one per cent, whether present intentionally or as impurities, is considered. In view of the growing appreciation of the influence of minor constituents upon the properties of metals, this book will be welcome to metallurgists.

F.P.H.

The chemical destruction of cast iron. W. DENECKE. *Giesserei*, **15**, 307–12(1928).—Corrosion of cast Fe (I) is ascribed to chemical causes, local elements, and erosion. To study the dissolving action of alkalis and acids on I (containing besides graphite, less than 1% Si, Mn, P, S, and perhaps Cu or Ni) specimens are suspended in: (1) molten KOH and NaOH for 18 and 20 hrs. and (2) 10% HCl for 46 hrs. In the molten alkalis, specimens containing Ni show the least, and those with Si, P, and S the greatest solubility, while no decidedly unfavorable influence of Mn could be detected. In the acids, the Si-rich specimens behave the best and those containing Ni, P, and S the poorest, while Mn acts favorably. The suspension of I containing Cu in 10% HCl for 24 and 43 hrs. at room temperatures shows that stability toward this acid is increased by Cu (optimum at 0.5%). The effect of Si on the solubility of I containing varying amounts of Si up to 17% is determined in boiling 15 and 10% H_2SO_4, and 5% HCl. The superiority of I with high Si content is clearly seen. The Guertler-Tammann Fe-Si diagram as modified by Körber, and the solidification fields of the Fe-Si-C alloys are discussed. The disadvantages of high Si content and the importance of the graphite distribution on the corrosion of I are briefly stressed. (*C.A.*)

PATENT

Porcelain or enamel-iron soap cup. PHILIP MUELLER. U. S. 1,701,690, Feb. 12, 1929. The combination of a vitreous lavatory fixture having a recessed wall engaging portion, a metal plate fastened in the recess and having a downwardly projecting projection with an inclined inner face forming with the wall of the recess a wedge-shaped space, and a metal support adapted to enter the recess with its upper end wedged into the space between the projection and the wall of the recess.

Glass

Determination of the source and means of prevention of stones in glass. HERBERT INSLEY. *Jour. Amer. Ceram. Soc.*, **12** [3], 143–52 (1929).—The microscopic characteristics of different crystalline materials occurring as stones or lumps in glass are described and photomicrographs of stones originating from devitrification of the glass incomplete solution of batch constituents, and incorporation in the glass of refractory wall material are reproduced. Methods of determining the location in the glassmaking system of the source of stones, using microscopic as well as other methods, are given. Means of prevention or elimination of the stones are suggested.

Effects of soda, barium, and zinc on elasticity and thermal expansion coefficients of glass. L. D. FETTEROLF. *Jour. Amer. Ceram. Soc.*, **12** [3], 193–216 (1929).—An investigation is made of the effect on the elasticity and expansion behavior of a base glass containing 60% SiO_2 and 40% Na_2O of replacing Na_2O in this glass by ZnO and BaO, respectively. The elasticity and expansion factors of the two oxides ZnO and BaO are determined and compared with published results. Elasticity factors of 80 for ZnO, 35 for Na_2O, and 55 for BaO are proposed. Cubical coefficient of expansion

factors of 12.5 Na_2O, 5.7 for BaO, and 1.85 for ZnO are also proposed. Neither the factors of Winklemann and Schott nor those of English and Turner fit very well the results reported in this paper.

Glass furnace design. A. ALISON. *Glass*, **5** [6], 240–45 (1928).—A. discusses in detail the combustion calculations for gas-fired furnaces. By means of tables the combustion calculations for 100 cu. ft. of producer gas are explained on the weight basis and the volume basis. By means of charts which are included it is possible to determine without calculations (1) weight of oxygen required, (2) weight of products of combustion, (3) weight of total waste gases, and (4) above factors on volume basis. **VII.** *Ibid.*, **5** [7], 289–92.—The following charts are given: (1) volume per lb. molecule of gases at temperature 0 to 2000°F, (2) alteration of volumes with temperature, (3) heat loss per 100 cu. ft. of gas from unburnt carbon monoxide, (4) weight of gaseous products from dissociation of batch. The effects of deficiency of air are discussed. **VIII.** *Ibid.*, **5** [8], 343.—Charts are given for the following: (1) variation of specific heat with temperature, (2) heat loss in waste products and by unburnt carbon monoxide, (3) minimum air required for combustion of 100 cu. ft. of gas, (4) loss of heat per pound from 60° F with exit temperatures of 60° to 2500°F, (5) calorific value of producer gas from its analysis. **IX.** *Ibid.*, **5** [9], 396.—A. discusses very completely the subject of flame temperature and gives illustrative calculations. Charts are given for (1) calorific intensity of combustion of carbon monoxide, (2) flame temperatures, (3) relations between temperature, heat content, calorific value. For previous abstracts see *Ceram. Abs.*, **7** [8], 525; [9], 606 (1928); **8** [3], 180 (1929). A.J.M.

New turret lathe equipment for machining bottle molds. ANON. *Glass*, **5** [6], 246 (1928). A.J.M.

Factory management. S. S. COCHRANE. *Glass*, **5** [6], 255 (1928).—C. discusses the problem of factory management as applied to the glass industry. A.J.M.

Corrosive action of glass on tank blocks. S. R. SCHOLES. *Glass*, **5** [6], 260 (1928); for abstract see *Ceram. Abs.*, **7** [6], 369 (1928). A.J.M.

Ultra-violet ray transmitting window glasses. S. ENGLISH. *Glass*, **5** [8], 338–40 (1928).—As a starting point in the investigations three alkali silicates were melted: (*a*) 20% Na_2O, 80% SiO_2; (*b*) 20% K_2O, 80% SiO_2; (*c*) 10% Na_2O, 10% K_2O, 80% SiO_2. Best quality Fontainebleau sand was used. The melts were carried out in unglazed porcelain crucibles. When free from seed, the glasses were formed into disks, which, after annealing in the ordinary way, were ground flat and polished to a thickness of 2 mm. The transmissions of these glasses were determined by taking photographs of the light passing through them from an iron or copper arc and analyzed by a Hilger quartz spectrograph. There was very little difference in the transmission of the different samples, each being transparent to about 2720 Angstrom Units. In other samples from further melts the mixed alkali silicate appeared sometimes just a little better than either of the single alkali glasses, and showed the 2620 A.U. line very faintly. Fused boric oxide is transparent to ultra-violet rays; its transparency, when melted with pure silica, was determined by using a simple borosilicate glass. Its transmission when examined as a cast slab about 6 mm. thick was surprisingly low, only extending as far as 2980 A.U. It was not possible to polish this slab and its transmission limit is not comparable with others which are given. It is clear that admixture of either soda, potash, or boric oxide with silica greatly reduces its power of transmitting ultra-violet rays. Several series of three component glasses were investigated, soda and silica being present in each in ordinary amounts, while the third component was one of the following: lime, magnesia, lead oxide, zinc oxide, alumina, boric oxide, baryta, zirconia. The glasses were ground and polished to 2 mm. thickness as before. The soda borosilicate transmitted better than any of the others, its limit being in the region

of 2620 A.U. It was the only one of these glasses which showed a transmission equal to that shown by the simple alkali silicates. It has been shown that lead oxide does not promote ultra-violet transparency. Since fused silica is so transparent to ultra-violet rays it was thought that glasses with a high proportion of this oxide might show a good transparency but no definite relation between SiO_2 content and transparency to ultra-violet could be established. Iron oxide in glass is effective in absorbing ultra-violet rays, ferric oxide being more powerful than ferrous oxide. Mixed alkali glasses containing, respectively, 30% BaO, 20 and 17% ZnO were made. The two zinc glasses transmit as far as 2740 and 2750 A.U., respectively, while the baryta glass transmits very weakly as far as 2780 A.U. There appears to be a little improvement as the result of adding ZnO. The B_2O_3 content was varied in one series from 15 to 30% in steps of 5% but no improvement in transparency was obtained. It was found that the introduction of part of the soda content of zinc borosilicates as sodium nitrate or as sodium sulphate decreased the transparency, the sulphate being more effective than the nitrate. It has been found possible to produce a glass which is reasonably easy to manufacture in sheet form and which is transparent to ultra-violet rays as short as 2560 or 2600 A.U. **II.** *Ibid.*, **5** [9], 388–91.—The composition of the glass must be so adjusted that devitrification is improbable and yet the ultra-violet transparency must be maintained. As a rough method for testing the ultra-violet transparency of a glass, the use of a quartz spectroscope with a special fluorescent screen is fairly satisfactory. If a permanent record is desired, a quartz spectroscope may be used and the transmission registered on a photographic plate. For precise work neither of these methods is perfectly satisfactory since both show the extreme limit of transparency. What is desired in window glass of this type is not a long transmitted spectrum, but a high degree of transparency in the region between 2950 and 3200 A.U. This degree of transparency may be determined by certain chemical methods but the best way to carry out the determination is by the use of an ultra-violet spectrophotometer with which it is possible to determine the actual percentage transmission of rays of definite wave-lengths. Curves showing the percentage transmission, however, are not entirely free from the possibility of giving misleading impressions unless the thickness of the samples to which the curves refer are given. It has been shown that the transparency of glasses for ultra-violet rays gradually decreases when they are exposed to the direct action of the sun. This is known as solarization. Tests were made with glasses that had been exposed to sunlight for varying periods of time. It was found that in spite of the fact that the first two months of exposure were winter months they were distinctly more effective in reducing the transparency of the glasses than either of the succeeding periods. It appears safe to say that under the conditions of exposure used glasses reach a state of complete solarization in about 4 months. The effect of solarization may be produced by the use of a quartz mercury vapor lamp for a few hours. The first hour's exposure to the mercury lamp was found to be much more effective than any of the succeeding periods. This is similar to the action of the sun's rays. With the mercury lamp, degeneration of the glass is practically complete in five or six hours Photographs show how closely the natural deterioration is reproduced by the action of the mercury vapor lamp. **III.** *Ibid.*, **5** [11], 501.—If a glass of a certain type is fairly transparent to ultra-violet rays, the addition of iron oxide decreases the transparency but this effect will be less when the iron is in the ferrous state than when it is in the ferric state. The aging or solarization of ultra-violet glasses is similar to the development of a purple color in manganese-containing glasses (*e.g.*, pavement prisms, old plate, and cathedral glass) when exposed to the sun for a prolonged period or to the action of the mercury arc for a few hours. It is well known that a purple color developed in this way may be removed by heating the

glass for a short time up to its annealing point and, consequently, if these two processes are similar, it should be possible to restore the ultra-violet transparency of an aged glass by the same treatment. The experiment was tried by E. and in each case the original transparency was again developed. There seems to be no doubt that the aging of ultra-violet glass is fundamentally the same as the development of purple color in glasses containing manganese. This latter change is generally looked upon as an oxidation process promoted by the chemically active ultra-violet rays. Accepting this view, the mechanism of the aging process becomes obvious: it is simply the oxidation of the iron in the glass from the ferrous to the ferric condition. It is to be expected that glasses which are melted under definitely reducing conditions will show a transient transparency to the shorter ultra-violet rays. Some technologists and manufacturers have included chlorides in the batch in the hope that ferric chloride would be formed and volatilized but the attempt has not been successful. A.J.M.

American and foreign patents on safety glass. JOSEPH ROSSMAN. *Glass Ind.*, **10** [2], 35 (1929).—A list of 51 U. S. patents, and a partial list of foreign patents including 26 British, 21 French, 5 German, 2 Austrian, 2 Swiss, one Netherland, and one Norwegian patent on safety glass are presented. See also *Ceram. Abs.*, **8** [3], 181 (1929). E.J.V.

The Navy and the glass industry. G. K. SPENCER. *Glass Ind.*, **10** [2], 37 (1929).—All glass used on modern ships of the battle line must be of the highest procurable grade in each of the types used. Gage glasses have been developed which can stand the shock of firing dead ahead, in which case the ship must absorb the entire recoil in herself, as if the ship were struck by 14-inch projectiles. Nonshatterable glass has come into use in electrical gages. From the wired-glass portholes to the gages and nonshatterable glass of the engine rooms, and the nonshatterable plate glasses of the upper works, a total tonnage of five units is included in the displacement of a modern battleship of the line. Considering the size of the Navy it can be seen just what a glass-consuming organization the sea force of the U.S. is. E.J.V.

American Window Glass Co. increases Fourcault equipment. ANON. *Glass Ind.*, **10** [2], 47 (1929).—The success of the American Window Glass Co. during the past year in converting its Belle Vernon, Pa., plant from the old cylinder process to the Fourcault process, has led the company to announce that their old plant at Arnold, Pa., will also be changed by the installation of 13 improved Fourcault process sheet glass drawing machines which will make it the largest single installation of its kind. These machines also will have a larger production capacity than any installation of Fourcault machines heretofore put in operation. The Belle Vernon plant, rebuilt at a cost of approximately $1,000,000, has been operating both day and night shifts with several hundred employees. In addition to making the regular single- and double-strength window glass, the Arnold factory will be specialized to make up to $^1/_2$-inch drawn glass, and that the production of sheet glass and eventually plate glass for making laminated glass will involve a substantial part of the plant's capacity. Plans are also under consideration for installing two grinding and polishing units for converting part of the glass into polished plate, each of which will be able to turn out 7,500,000 sq. ft. of polished glass a year. E.J.V.

Production of plate glass. P. A. HUGHES. *Glass Ind.*, **10** [2], 47 (1929).—Figures compiled by the secretary of the Plate Glass Mfrs. of America show the total production of polished plate glass for 1928 was 130,649,435 sq. ft. These figures represent the entire industry in the U. S., and can be summarized as follows: 1st quarter, 31,465,932 sq. ft.; 2nd quarter, 32,795,701 sq. ft.; 3rd quarter, 33,022,654 sq. ft.; 4th quarter, 33,365,148 sq. ft. Of this total, 10,578,867 sq. ft. were produced in December, 1928. E.J.V.

History of glass. CHARLES MILLER. *Pottery Gaz.*, **54** [620], 288 (1929).—Abstract of an address in which it was stated that the Huguenots commenced works at Tyneside when driven out of their own country because of their religious beliefs, and that district, at the end of the 18th and the beginning years of the 19th Century, was a center of industry. Specimens of glass, including pieces artistically engraved and beautifully colored, proved that work of exceptional quality was turned out. E.J.V.

Glass manufacture in Russia. ANON. *Pottery Gaz.*, **54** [620], 296 (1929).—The Glass Trust of Leningrad has begun the new production of colored glass for the railways and industry, as well as glass for microbiological investigation, which has hitherto been imported from abroad, besides fire-resisting glass for glazing factories. Foreign-made equipment is being installed in the Badayeff factory, which will enable large quantities of fire-resisting glass to be produced daily. E.J.V.

Increased duty on hand-made glassware and bottles requested. ANON. *Nat. Glass Budget*, **44** [38], 3 (1929); *Amer. Glass Rev.*, **48** [16], 15, 23 (1929).—A plea for the fast-vanishing glass bottle blower was made before the House Ways and Means Committee on Jan. 12, when it was considering, in connection with the proposed re-adjustment of the tariff those paragraphs which have to do with glass and glass products. An effective plea was presented by James Maloney, president of the Glass Bottle Blowers Assn., and oral arguments urging an increase in the duty of hand-made bottles were made by representatives of the manufacturers. E.P.R.

Houses of glass bricks. ANON. *Amer. Glass Rev.*, **48** [17], 17 (1929).—Commercial development of glass bricks designed for the erection of buildings is now going on in the U.S. Plans for construction of one building in New York City are now under way. E.P.R.

Department store of glass built in smoke-infested German city. ANON. *Amer. Glass Rev.*, **48** [18], 13 (1929).—In an effort to overcome the effect of smoke and soot in the atmosphere, the Sinn Co. has erected a glass department store in Gelsenkirchen, Germany. The façade is glass with bronze trimming, and floors, walls, and stairways are glass. E.P.R.

Arsenic. F. Y. ROBERTSON. *Mineral Ind.*, **36**, 34–39 (1927).—Arsenic is found in the uncombined condition in various localities but more generally in combination with other metals and sulphur in the form of more or less complex sulphides. The ordinary commercial or white arsenic is produced, in the U.S., largely as a by-product recovered from flue dust and fumes at smelters in the western states. Sulphurous gases and fumes containing arsenic from the furnaces are precipitated by being drawn through baghouses or by the electrical precipitation of particles from the fume and gas by the Cottrell treater. After the arsenic fumes and dust are precipitated, they are refined by special furnaces or reverberatories, the result being a high-grade, fine white commercial arsenic product analyzing 99% or more of As_2O_3. E.P.R.

Borax. PAUL D. V. MANNING. *Mineral Ind.*, **36**, 64–68 (1927).—At the present time, the crystallized tetraborate ($Na_2B_4O_7 \cdot 10H_2O$) and boric acid (H_3BO_3) are the most important boron derivatives commercially. Work is being done on the use of colemanite as a glaze in pottery and as a flux in smelting. There is much opportunity for research in this industry and with the constantly lowering price, borax may eventually replace soda ash in certain specialized industries. The commercial sources of boron products up until several years ago were almost entirely from colemanite, which is the hydrous borate of calcium ($Ca_2B_6O_{11} \cdot 5H_2O$) and ulexite, which is the hydrous borate of calcium and sodium ($NaCaB_5O_9 \cdot 8H_2O$). Most of the principal deposits of colemanite and ulexite in the U.S. are found in Calif. and Nev. E.P.R.

Cryolite. ANON. *Mineral Ind.*, **36**, 202 (1927).—Cryolite, a mineral having the composition Na_3AlF_6, is mined only at Ivigtut, Greenland. Shipments are made by

the mine operators only to Denmark and the U.S. There has been a large increase in value per ton in the past two years, doubtless in keeping with an increased demand. The largest consumers of cryolite are the producers of aluminum and the manufacturers of opaque glass. E.P.R.

Bottle factory in British Columbia. ANON. *Chem. and Ind.*, **48**, 85 (1929).—A glass-bottle factory is being established at New Westminster, B. C., by Californian capitalists. This is the first plant of its kind to be erected in Canada west of Ontario. H.H.S.

Largest single unit sheet glass plant. ANON. *Ceram. Ind.*, **12** [2], 184–98 (1929).—A description is given of the plant and equipment of the Libby-Owens Sheet Glass Co. at Charleston, W. Va. The plant covers 35 acres and represents an investment of $10,000,000. Several series of storage bins have a capacity of 50 carloads of sand, ground limestone, soda ash, and salt cake. The cullet storage has a capacity of 50 carloads. Five hundred tons of raw materials and cullet pass over an elaborate conveyer system every day. The rated conveying capacity is 60 T. per hour. Twelve furnaces, during operating periods, contain 600 to 900 T. of molten glass. There are 18 leers, 200 feet long with 200 power-driven rolls. These leers are thoroughly insulated, the temperature is not permitted to vary more than ± 3 to 5°. F.P.H.

Tanks for white glass. Prevention of defects encountered in operation. S. G. *Keram. Rund.*, **36**, 445–49 (1928).—Decolorizers for glass made in tanks are of two kinds: those having a physical action and those having a chemical action. To the first type belong all selenium, nickel, cobalt, manganese, and sometimes chromium preparations as well as the rare earths, neodymium, erbium, etc. These elements produce a color which neutralizes the color introduced by impurities such as iron. Se or Ni is generally used. Compounds of the second type are generally reducing or oxidizing agents at furnace temperatures. Arsenic, saltpeter, superoxides, perchlorates, etc., are generally used. Care must be taken to avoid oxidizing Se. It may be used as the element or as Na_2SeO_3. Arsenic may be used to advantage with Na_2SeO_3 but not with metallic Se since it has an oxidizing action on the latter. The composition of the glass has an effect on the color produced by Se. Potassium glasses with Se have a salmon red color, Na glasses a somewhat unpleasant yellow-red color. No precise method of calculating the correct amount of decolorizer to use has been produced. The use of Se requires a somewhat reducing fire. Ni gives a violet-red color to K glasses, a brownish gray color to Na glasses. It is frequently used in tanks because it is not sensitive to changes in firing procedure or in melting temperatures but an excess of Ni produces a grayish appearance which makes the glass unsalable. Mn as Mn_2O_3 also acts as a decolorizer but because of its sensitivity to reducing conditions is seldom used in tank melts. Cobalt is satisfactory as a decolorizer for glasses containing sulphur compounds or organic impurities. Only a small amount is required and it is very stable chemically in glass melts. Arsenic may be either reducing or oxidizing in its action depending upon conditions. It generally acts as a decolorizer by raising the Fe from the divalent to the trivalent state. With carbonaceous impurities As oxidizes the C to CO_2. H.I.

Conversion from hand to machine manufacture in the sheet glass industry (Fourcault system). F. STANG. *Keram. Rund.*, **36**, 461–63, 483–85 (1928).—Although the advantages of machine manufacture by the Fourcault system as compared with hand manufacture are obvious, the former method requires more careful control of batch compositions and of temperatures. Compositions which give the proper degree of viscosity and which do not tend to weathering or devitrification are essential for economical operation by this system. To avoid burning the gases too far above the glass surface in the melting chamber of the tank additional crown blocks may be inserted below the true crown or the ports may be so constructed that the gases are directed toward the

surface of the melt. Construction details and costs are given for converting a sheet glass plant using hand methods into one using the Fourcault system. Comparable manufacturing costs per square meter of window glass for German plants with the same monthly capacity are: for hand-blowing 1.80 M., for the Fourcault system 1.08 M. H.I.

Glass industry in China. F. STANG. *Keram. Rund.*, **36**, 491–93 (1928).—While China produces most of the hollow-ware which it consumes, it imports most of the sheet glass. Raw materials for glass production are plentiful, with the possible exception of soda. Chinese make satisfactory workmen and it is almost essential to employ Chinese salesmen and buyers. Opportunities for establishment of glass plants in China are good provided the government is not hostile to foreign employers. H.I.

Recent improvements in the manufacture of flat glass. H. K. HITCHCOCK. *Mech. Eng.*, **50** [5], 368–72 (1928).—H. touches on the early methods of making sheet glass, points out the generally accepted methods used, and outlines the most recent developments in the industry. The final development of the continuous method of casting from tanks and grinding and polishing is described. An improved method of casting from pots is given. L.A.P.

Conveying molten glass from melting furnace to place of fabrication. L. BOCK. *Sprechsaal*, **61** [32], 621–22 (1928).—The molding and shaping of glass took place at the melting furnace until quite recently. Transportation of molten glass required the use of either the blower's pipe or a ladle. On account of the necessity of working the glass within narrow temperature limits the transportation of the liquid caused great inconvenience. To overcome this a separate working hearth for the molten glass was built and the glass conducted by gravity through a channel from the tank to the hearth. The system was kept at the required working temperatures of glass. A description of this construction is given. R.A.H.

"Increasing" or "decreasing" decolorization. ANON. *Sprechsaal*, **61** [32], 622–23 (1928).—A discussion on decolorization of glasses on the basis of the following classification. (1) Chemical decolorization (oxidation of the ferr[ous] oxides to ferr[ic] oxide as with the aid of saltpeter). (2) Physical decolorization: (*a*) decreasing (withholding iron from the melt, less impurities in raw materials and chemicals); (*b*) increasing (suppression of the tinge (of color) by means of its complementary color). R.A.H.

Deduction on the homogeneity of glass from the "cell." ANON. *Sprechsaal*, **61** [34], 666–69 (1928).—(1) Glass during its transition from the batch mixture to the molten state passes through a stage when it appears to have a cell-like structure. (2) The size of the cell is dependent on the particle size of the batch materials. (3*a*) The individual cells are distinguished by equal grain size which for the time being overbalances the components from which they result. (3*b*) If the sand is coarser throughout than the fluxes, then the individual grain will be enveloped in a coat of metasilicate (Herman). (4) In the case of (3*a*) it is the limiting surface tension, which appears as partitions between the individual cells. With (3*b*) it is a frothy metasilicate covering which separate individual silicic acid cells. (5) The purification process is carried out in every case so that the rising gas bubbles tear the cell walls, new surfaces of contact are created and homogeneity is developed. (6) The character of the cells is found in all sizes and shapes. Any inhomogeneities are always cells which through limiting surface tensions have been separated from their surface coating. (7) The significance of the limiting surface tension has been recognized for some time. So the setting in of devitrification (according to Zschimmer and Tabata) which also may be observed from the flowing of the glass in the melting tank, whereby thermal and chemical diffusion take place, may proceed vigorously with receding temperatures. (8) According to the investigations of Tammann surface tension of the glass increased with increasing water content. In this connection,

there are the observations of Turner that high moisture content makes glass brittle on the basis of insufficient diffusion due to too high a limiting surface tension among the individual cells. R.A.H.

Moorshead press and blow machine. ANON. *Ceram. Ind.*, **12** [2], 200–201 (1929); *Glass Ind.*, **10** [2], 40–41 (1929); see Brit. 297,856, *Ceram. Abs.*, **8** [2], 112 (1929).

An improved hot-wire glass cutter. J. ALLEN BAKER AND HARRY H. HALDEMAN. *Jour. Chem. Education*, **5**, 1289–91 (1928). (*C.A.*)

Microstructure of glass. N. N. SMIRNOV. *Trans. State Expt. Inst. Silicates* (Moscow), **23**, 5–29 (1926).—The conditions responsible for the appearance of various crystalline products in glass as indicated by a number of mineralogical and chemical analyses are: $CaSiO_3$ in the form of needles of the monoclinic system of wollastonite crystallizes at 1000° and in the form of hexagonal plates at very high temperatures. Both of these forms are characteristic for glass of a high Ca content. Apparently Ca silicate forms supersaturated solutions in sodium silicate; at a high content of Mg and Fe in glass other pyroxenes of the augite series crystallize. SiO_2 crystallizes from glass as tridymite and cristobalite. It is possible that the concentration of Ca salts takes place in connection with the accumulation of the more heavy part of the glass in certain places of the bath. A miniature magmatic differentiation takes place and the heavier silicates of calcium crystallize. S. shows that these silicates belong not only to wollastonite, but apparently to the other compounds of the type $3CaO{\cdot}2SiO_2$ and $2CaO{\cdot}SiO_2$. (*C.A.*)

PATENTS

Glass-forming machine. RICHARD LA FRANCE. U. S. 1,699,566, Jan. 22, 1929. In a machine for forming glass articles, the combination of a rotating mold carriage comprising a plurality of heads or units, a plurality of molds carried by each unit, each mold having a plurality of mold cavities, means for effecting a simultaneous discharge of articles from all the mold cavities of a mold, and adjusting means by which articles concurrently formed in a mold are caused to be discharged in succession.

Glass-fabricating machine. WILLIAM J. MILLER. U. S. 1,700,326, Jan. 29, 1929. (1) In a glass machine, the combination of a rotary mold table, the table being interiorly chambered to contain a blast of air, means for supplying air to the table, molds mounted on the table, ports in the table adjacent to the molds, blast pipes leading from the ports and having their discharge ends directed against the molds to cool the latter, and means for regulating the height of the discharge end of the pipes to suit various characters of molds. (2) In a glass machine, the combination of a hollow support, a mold table rotatably mounted on the support, a stationary wind box mounted on the support above the table, means for admitting air blast to the support, means for admitting air blast from the support to the box, and tubular means leading from the box to portions of the machine for cooling the same. (3) In a glass machine, a moving mold support, partible blow molds mounted on the support, a take-out device adapted to remove the blown ware from the molds, means for intermittently rotating the support to bring the molds in turn to the take-out position, a rocking lever pivotally mounted intermediate of its ends, means for rocking the lever when a mold assumes the take-out position, and means whereby when the lever is rocked one end opens the mold in the take-out position and the other end closes the mold which has passed from the take-out position. (4) In a glass machine, the combination of a movable mold support, a plurality of partible molds mounted on the support, means for moving the support whereby the molds are brought in turn into the take-out position, means for opening the molds as they assume the take-out position, means for taking out the ware, and means for tilting the bottoms of the open molds after the ware is taken out therefrom.

Apparatus for drawing sheet glass. GEORGE G. ROBERTS. U. S. 1,700,420, Jan. 29, 1929. (1) In an apparatus for drawing sheet glass, a crucible-chamber and means

for heating the same, a drawing-chamber arranged above the crucible-chamber, means in the chamber for drawing the sheet, a shield arranged above the crucible-chamber and provided with a sheet-drawing opening, the crucible being set at a point below the shield and coincident with the opening whereby the heat generated in the crucible-chamber will flow up around the sheet at the place of formation and into the drawing-chamber. (2) A takedown apparatus embodying a tray for receiving the drawn sheet of glass, a support for the tray and means for moving this support toward and from the drawing-chamber, and means whereby the support and the tray are automatically tilted to a vertical position in the drawing-chamber to receive the upright sheet of glass and whereby the tray and support are tilted back to horizontal position when moved away from the drawing-chamber.

Laminated glass and process of producing the same. JOHN L. DRAKE. U. S. 1,701,147, Feb. 5, 1929. As a new article of manufacture, a sheet of laminated glass including a sheet of nonbrittle material having a film of vegetable oil plus camphor thereon.

Method and apparatus for heating molten glass. ARTHUR E. FOWLE. U. S. 1,701,151, Feb. 5, 1929. In sheet-glass drawing apparatus, a draw-pot containing molten glass from which a sheet is drawn, a heating chamber surrounding and supporting the draw-pot, and means for heating the chamber by electricity and gas.

Width-maintaining means for sheet-glass apparatus. JOSEPH M. NEENAN AND JAMES P. WEAVER. U. S. 1,701,161, Feb. 5, 1929. In sheet-glass apparatus, means for drawing a sheet from a mass of molten glass, including width-maintaining means, and means for directing a jet of air onto the edges of the sheet before the edges contact with the width-maintaining means.

Sheet-drawing apparatus. CHARLES W. SWOPE. U. S. 1,701,165, Feb. 5, 1929. In sheet-glass apparatus a receptacle containing a mass of molten glass, means for drawing a sheet of glass therefrom, and a roll arranged on each side of the sheet and fitting substantially into the natural curvature of the base of the sheet, the rolls creating a sheet forming a pass and producing a sheet of substantially predetermined and uniform thickness.

Apparatus for marking glass articles. DANIEL K. WRIGHT. U. S. 1,701,348, Feb. 5, 1929. In a device of the character described the combination of a stationary yielding stamp normally flat and constructed to conform to the curved wall of a bulb or similar article pressed into the stamp, a bulb holder mounted to move toward and away from the stamp and constructed to hold a bulb with a curved portion in registry with the stamp and means for automatically moving the holder toward the stamp to bed the curved portion of the bulb in the stamp and print a mark upon it and then move the holder away from the stamp.

Glassworking machinery. ROY D. MAILEY. U. S. 1,701,758, Feb. 12, 1929. In a glassworking machine, in combination, means for holding a hollow piece of glass, means for holding another piece of hollow glass to be sealed to first piece, means for rotating the glass pieces at the same rate, means for moving the holding means relatively toward and from each other, the holding means being movable relatively transversely of each other, and means for heating glass pieces carried by the holding means.

Glassworking machine for switches. GEORGE A. MILLAR. U. S. 1,701,759, Feb. 12, 1929. In glassworking machinery, in combination, a plurality of sets of chuck jaws, means for each set tending to hold the jaws thereof in the open position, confining means for causing the jaws of each set to move into the closing position, means tending to move the jaws into their respective confining means, and a single means for moving the sets of jaws separately at will from their respective confining means to permit the opening thereof, the moving means being movable relatively into and out of position for operating either set of jaws.

Process and apparatus for drawing glass. ARTHUR E. SPINASSE. U. S. 1,701,899, Feb. 12, 1929. In apparatus for drawing sheet glass, a slot member for supplying glass to the base of the drawn sheet, the walls of the slot projecting at different depths at different points in the glass bath.

Coloring glass for electric lamps, etc. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 300,179, Dec. 31, 1928. In the method of coloring electric-lamp bulbs, etc., wherein the bulb is frosted on the inner surface and a dry powdered pigment is caused to settle in the frosted surface, the pigment comprises (*a*) a mixture of a fine and a coarser powder, and (*b*) a powder containing tungstic oxide. Oxides, sulphides, and silicates of iron, cadmium, chromium, cobalt, selenium, titanium, tungsten, and zirconium may be used as pigments. Red phosphorus may be added as a getter. A pebbled appearance may be imparted to the coating by adding a quantity of shot to the pigment.

Rotary glass furnaces. G. ZOTOS. Brit. 300,576, Jan. 9, 1929. Raw materials for the manufacture of glass are fed continuously to a rotary furnace fired by a gas, oil, or powdered fuel burner, and the molten product is withdrawn from the inner part of the layer of glass formed in the furnace. In the apparatus shown the furnace is enclosed within a casing, through which cooling air is passed, and is fired by a burner passing through a glass collecting space having drawing-hearths connected thereto. The discharge neck of the furnace is cooled by an air jet so that a protective layer of solidified glass is formed thereon. The hot air from the casing may be further heated in a recuperator, and then used partly for combustion in the furnace and partly for supply to a gas producer, while the waste gases from the furnace may be used partly in the recuperator, and partly in an annealing furnace. The axis of the burner is arranged at an angle or eccentrically to the drum and the gas is delivered with such velocity that the flame is formed at some distance from the delivery nozzle. The neck through which the molten glass is delivered is notched, so that the flow of glass is concentrated at one or two points, and to prevent the viscous stream from winding round the neck the furnace is inclined, or the glass is drawn off immediately on delivery by a drawing-machine, or by cooled suction pipes.

Glass manufacture. SOC. ANON. D'ÉTUDES ET DE CONSTRUCTIONS D'APPAREILS MÉCANIQUES POUR LA VERRERIE. Brit. 300,638, Jan. 9, 1929. In a machine for making glass bottles or similar hollow ware, the parisons are blown in the finishing mold by suction applied between the parison and the wall of the mold, the glass being distended by the pressure of the atmosphere. The mold consists of two parts as usual, and channels formed in the meeting faces of the two parts communicate by borings with a conduit formed in the mold bottom. When a parison is enclosed in the mold, suction is applied through the conduit and the air inclosed in the space is exhausted through the joints between the mold halves. The pressure of the atmosphere, acting through the opening in the neck of the parison, expands it until it fills the mold.

Drawing and forming glass tubes. P. A. FAVRE. Brit. 300,646, Jan. 9, 1929. In a method of making tubing, a class cylinder with an axial bore is heated until it is plastic, and is then drawn in the direction of its length to form tubing of the required diameter. The cylinder is threaded on to a metal former consisting of a tube which terminates in a bulbous enlargement. The lower end of the cylinder is heated by suitable means, such as burners until the glass melts and flows by its own weight around the bulb. A tubular bait is stuck on to the glass and is drawn downward by suitable apparatus, such as opposed endless belts, and the drawing is continued at such speed that the glass drawn away from the bulb forms tubing of the required diameter. As the hot glass is drawn away, the cylinder slips downward and is progressively melted. As the tubing leaves the drawing belts, it is notched at intervals by any suitable means, and an oscillating

member breaks off the lowermost length and deflects it into a shoot. Means are provided for bringing a new cylinder into place above the burner when one is exhausted.

Rolling sheet glass. J. H. LEMAIRE. Brit. 301,083, Jan. 16, 1929. Relates to the manufacture of glass plates and sheets by rolling, and consists in forming molten glass into a sheet of regulated thickness which is immediately passed between rollers to reduce it to the final thickness. The apparatus for forming the sheet consists of a trough rectangular in plan and provided with a slot, the width of which can be regulated by movable plates. Molten glass, placed in the trough, flows out through the slot in the form of a sheet, the thickness of which is regulated by the plates. The sheet thus formed passes between rollers which reduce it to the final thickness. The trough may be charged with glass either from a pot or a ladle or direct from a tank furnace. The trough and rollers may be fixed above a movable table, or a roller conveyer, for receiving the finished sheet, or they may be arranged to move horizontally above a stationary table. In a modified construction, the plates are replaced by rollers which form the sheet, and wire netting may be pressed into the glass by these rollers when making reinforced glass.

Glass-melting furnaces. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 301,919, Jan. 30, 1929. A device for stopping a stream of molten glass from flowing through an outlet in a tank furnace or forehearth comprises a stopper which rests on the lower lip of the outlet and is supported in an inclined position, so that flames and hot gases can pass through the outlet over the surface of the glass. By this means, the stopper and the neighboring parts are kept sufficiently hot to enable the stopper to be removed easily when the flow is to be started again.

Heavy Clay Products

Correction of an extreme case of cracking in the drying of brick. HOWELLS FRÉCHETTE AND J. G. PHILLIPS. *Jour. Amer. Ceram. Soc.*, **12** [3], 153–61 (1929).—I. In the manufacture of stiff-mud brick from a highly colloidal clay of low permeability to water, drying breakage was extremely high even though the drying was conducted at a very slow rate under high humidity conditions. Laboratory investigation yielded two methods of correcting the faults: (1) Preheating the clay for half an hour at a temperature between 400 °C and 500 °C increased the permeability to such an extent that brick made from the preheated clay could be dried rapidly without cracking. (2) Coagulating chemicals, such as aluminium chloride, ferric chloride, sodium chloride, and hydrochloric acid, in conjunction with moderate additions of grog, increased the permeability and thus improved the drying properties of the clay. II. Plant scale tests using ferric chloride, sodium chloride, and grog resulted in the production of brick which could be dried safely in a reasonable time. The fired brick were improved in quality as to strength and color. III. The chemical treatment of the clay using 1% ferric chloride and 0.5% sodium chloride with 10 to 15% grog was adopted for plant operation and resulted in increased production, lower cost of manufacture, and improved quality of product.

Clay-winning equipment. ANON. *Brick Clay Rec.*, **74** [4], 265 (1929).—R. B. Muffett & Son, Ridgefield, Wash., manufacturing building, drain tile and brick, has installed machinery for the winning of clay. The boom of the digger is equipped with a revolving cylinder made in 3 parts of cast steel each part having 2 picks attached to it. The 6 picks operate at about 350 r.p.m. and with a downward motion throw the clay onto the conveyer set within the girders of the boom and thence to the car below. Clay is dug downward from the top of the bank making a cut of 18 in. width and 10 in. depth. As the clay is dug from the face of the bank the machine moves back on its upper frame

and thus the bank is always slant to prevent a cave-in. The machine is moved on rails by a windlass on each corner. The lumps of clay usually do not exceed 4 in. in diameter. E.J.V.

Modernization of Chicago brick plants. ANON. *Clay-Worker*, **91** [1], 38–60 (1929).—Chicago is the greatest common brick-producing center of the world with an annual production of about 1,200,000,000. With 25 plants producing a common product, the individual owners had to keep pace with the progress of industry. Any change in a plant that worked for greater efficiency putting the operation of that plant on a more economical basis was generally adopted by others so that most of the Chicago plants made radical changes from time to time to meet the new conditions set up by keener competition due to more efficient methods. Many of the plants, have decidedly distinct features not found on others. Descriptions of several Chicago plants are given. E.J.V.

Factory design and equipment. XX. T. W. GARVE. *Clay-Worker*, **91** [1], 62 (1929).—Retaining walls are found in clay plants for (1) retaining stored clay and other raw or ground materials above ground (or at times below ground), and (2) retaining a level yard along a depressed railroad track. The former walls are subject to great variations in their design to conform to the material, storage capacity, manner of handling, plant layout, and building design. Methods of calculating the strength of retaining walls, and the load or pressure applied to them by the stored materials, are given and illustrated. For previous abstracts see *Ceram. Abs.*, **8** [1], 33 (1928). E.J.V.

YF machine for Young facing process. ANON. *Clay-Worker*, **91** [1], 72 (1929); *Brick Clay Rec.*, **74** [4], 268 (1929).—The Fate-Root-Heath Co. of Plymouth, Ohio, has brought out a special machine called the "YF Brick Machine" for making brick by the Young facing process. By this process two clays, differing radically in physical and chemical properties, are prepared and fed separately into the brick machine; they emerge through the die bonded into a single homogeneous column. The advantage in making this face brick is that the facing is an integral part of the brick. The idea was one of economizing on costly materials, but it would now seem that economy is but one of many advantages. It has long been desirable to use light porous brick in facing steel structures, because of their insulating properties and light weight. The objection to such brick is that they absorb water too readily. By means of the Young facing process a brick could be produced which would have a light porous body and a thin dense face which would prevent the absorption of moisture. No such brick as that described has ever been made but it is thought that by means of the YF machine it could be made. The various effects in color and in structure would seem to be limited only by the imagination and the ingenuity of the users of the machine. E.J.V.

Exports in brick and clay building materials. ANON. *Clay-Worker*, **91** [1], 73 (1929).—The export record for the first ten months of 1928 shows considerable increase in exports of brick and clay building products. Following are the official statistics:

	Ten months ended October 1927	1928
Building brick and hollow tile	$ 142,505	$ 201,970
Fireclay brick	774,958	676,170
Other refractory brick	1,085,820	1,115,604
Refractory shapes	635,864	980,473

Brick of all kinds imported from foreign countries in the ten months of 1928 totalled $520,139, of which $375,101 came in free of duty and $145,038 were dutiable. E.J.V.

Brick from lime-kiln waste. EDMUND SHAW. *Rock Prod.*, **32** [2], 51–52 (1929).—Klinker brick is the trade name of a brick made from cinders and hydrated lime and at present the only plants making it are in El Paso, Tex. The cementing power of a

mixture of lime and cinders has long been known and masons have used it for topping chimneys and in other work where a weather-resisting mortar was needed. By steam curing, the cinder-lime brick becomes much harder than it would by setting in air. The strength of the cured brick is about that of good concrete, the compressive strength running about 3500 lb. and the modulus of rupture 650 lb. The absorption of the brick can be varied in the process, and it is possible to make a brick with almost no absorption. For practical reasons the absorption is kept at 10%. The weight is about two-thirds that of a common clay brick. F.P.H.

Dry press in brick manufacture. WILLY KITT. *Tonind. Ztg.*, **52** [46], 934–35 (1928).—Recently developed equipment used in the manufacture of brick by the dry-press method is described. F.P.H.

Heat conductivity of building materials. LUDWIG RUDOLPH. *Tonind. Ztg.*, **52** [47], 949 (1928).—The following data are given for some of the common building materials:

Material	Approximate density kg./m.³	Cal. m./hr. °C	Material	Approximate density kg./m.³	Cal. m./hr. °C
Quarry stone	2300	11–14	Masonry with brick of high porosity	900	0.20
Cement masonry	1830	0.77	Masonry with unfired brick	1800	0.50
Gravel concrete	2000	0.70	Wood	640	0.15
Sand lime brick masonry	1670	0.60	Cinder filling	1000	0.15
Brick masonry	1680	0.40–0.50			

F.P.H.

Developments in clayworking machinery for heavy clay products. ANON. *Tonind. Ztg.*, **52** [48], 969–72 (1928). F.P.H.

Artificial brick drier. V. PINKI. *Tonind. Ztg.*, **52** [50], 1012–13; [52], 1117–19 (1928).—A discussion is given of the various types of driers, methods of placing brick in driers, and of circulating air through driers. F.P.H.

Hollow building brick. LOUIS SCHMELZER. *Tonind. Ztg.*, **52** [59], 1191–92 (1928).—A new type of building unit in the shape of a cube is described and its advantages enumerated. F.P.H.

Fire resistance of hollow load-bearing wall tile. S. H. INGBERG AND H. D. FOSTER. Bur. Stand., *Jour. Research*, **2** [1], 1–334 (1929).—Three series of fire tests of wall construction built of hollow load-bearing wall tile of representative designs and clay materials are reported. The first tests were made on wall sections 1 x 6 ft. subjected to fire on one side while under working load, the main object of the tests being to determine how the fire exposure affects the individual tile units. This was found to vary with the type of clay used, hardness of firing and design of the unit, from minor cracking of a few of the units in the specimen to failure under load a little after 2 hours. The second group of tests was with wall specimens 4 x 4 ft. tested, exposed to fire on one side, under load or restrained within the containing frames, and were made to study the effect of changes in design of the unit, and in the constituents and preparation of the clay. Addition of up to 2% of ground fired clay (grog) to the raw clay was found to be without effect, but higher percentages increased the fire damage, apparently because of initial shrinkage cracks radiating from the grog particles. Additions of up to 15% by volume of sawdust to the raw clay decreased the tendency to cracking when exposed to fire without seriously decreasing the normal strength of the tile. Finer grinding and greater amount of pugging of the raw clay increased the strength of the tile and consequently its load-carrying ability when exposed to fire. Of modifications in the design of the unit, one with double outside shells improved the fire resistance for all but very dense tile in confining the cracking mainly to an outer thin shell. Increased shell thickness was also found to decrease the fire effects, as also fillets up to $^1/_4$-inch radius at the junctions of shells and

webs. The final series consisted of 167 fire-endurance tests and 4 fire and water tests of typical wall constructions, 71 of which were made with walls between 10 and 11 ft. high and 8 to 16 ft. wide. The thickness ranged from 8 to 16 in., and plaster, stucco, or brick facing was applied on a number of walls. The walls were subjected to constant applied loads of 70 to 120 lbs./in.^{2} during the fire test, were restrained within the containing frames, or were tested unrestrained, the latter condition being representative of walls in low buildings or the upper story of higher buildings. The results are summarized as fire-resistance periods, which are determined by the time the walls sustained load under fire exposure and prevented the average temperature rise on the unexposed side from exceeding 139°C (250°F) or the maximum rise at any point where temperature measurements are taken from exceeding 180.6°C (325°F). Freedom from cracks or openings large enough to transmit flame or ignite combustible materials is also required both in fire-endurance tests and fire and water tests. The final grouping of test results is in three classes determined by the design of the tile. Fire-resistance periods are given for 8-, 12-, and 16-in. walls in each class, the values varying with the thickness and design from 1$^3/_4$ to 11 hrs. for unplastered walls and from 4 to 15 hrs. for walls plastered on both sides. Periods are also given for walls assumed to have combustible members projecting into them 4 in. from the unexposed side, this being determined by the time required for temperatures high enough to ignite wood to obtain at the given depth in the wall. Fire-resistance periods for this condition ranged from 1 hr. with 8-in. unplastered walls to 10 hrs. with 16-in. plastered walls built of tile of the designs giving the highest results. R.A.H.

Drying behavior of shales and clays. ANON. Bur. Stand., *Tech. News Bull.*, No. 140, 175–76 (1928).—Some preliminary data on the drying behavior of clays are reported. A brick made from Rutland (Ohio) alluvial clay could lose about 76% of the added tempering water when dried at an average temperature of 26°C and an average humidity of 94% for 244 hours. Reabsorption of water on proper change of condition could be made and expansion takes place coincidently. It is possible that considerable drier trouble might be traced to such change of conditions. Shrinkage has practically ceased when about 75% of the tempering water has been eliminated, and varies with the length of time required to dry the brick. R.A.H.

Absorption of clay brick. ANON. Bur. Stand., *Tech. News Bull.*, No. 141, pp. 3–4 (1929).—In connection with an investigation sponsored by the American Face Brick Assn. of the factors controlling the moisture transmission of brick masonry, a study has been made of the absorption properties of 9 types of clay brick. The samples of each type were selected to give as wide a range in the properties as could be obtained from several hundred marketable products. Absorption tests were made in 3 ways: (1) total immersion at 20°C; (2) total immersion in boiling water for 7 hours; (3) partial immersion at 20°C for several periods. The results of the tests indicate that the relations between the amounts of water absorbed by total immersion at 20°C and by boiling were given closely by the empirical equation $Y = KX^3$ or $Y = K\left(\frac{Y}{Y+Z}\right)^3$, where Y = volume of water absorbed per unit of bulk volume of brick after total immersion at 20° C. $Y+Z$ = volume of water absorbed per unit of bulk volume of brick after 7 hours in boiling water. K = a constant for any one make of brick. $X = \frac{Y}{Y+Z}$ = ratio of absorption by cold immersion to absorption by boiling. With any one type of brick the values of the ratio (X) decreased with a decrease in the apparent porosity of the brick. By combining the equations $Y = KX^3$ and $X = \frac{Y}{Y+Z}$ and solving for Z it is found that Z is

a maximum when $X = {}^2/_3$. This relation was borne out by the results of the test. R.A.H.

Automatic cutting tables. ANON. *Brit. Clayworker*, **37** [440], 342–44 (1928).—A review with illustrations of cutting machines manufactured by the Fate-Root-Heath Co., Plymouth, O., the E. M. Freese & Co., Galion, O., the Bonnot Co , Canton, O., W. A. Riddell Co., Bucyrus, O., and J. C. Steele & Sons, Statesville, N. C. R.A.H.

Hanover Brick Co. ANON. *Brick Clay Rec.*, **74** [2], 93 (1929).—An illustrated description of the rebuilt plant of the Hanover Brick Co., Hanover, Ohio, which is brick and steel and entirely fireproof. Clay is brought in by locomotive on a high trestle and dumped directly into the dry pan through a chute. The product is a high-grade red face brick fired in downdraft kilns and dried in steam drier. E.J.V.

Clay and steel build the modern home. ANON. *Brick Clay Rec.*, **74** [2], 97 (1929).—An all-steel frame embodying an entirely new brick veneer construction being erected in a suburb of Pittsburgh, and known as the "Steeltex House," has been attracting considerable interest in building circles. Over the exterior surface of the steel framing members a welded-mesh reinforcing fabric that has a heavy waterproof backing is applied by means of clips attached to the studs and corner posts through the perforations. A 4-in. brick facing is laid on the fabric and the cement mortar is run down in back of the brick against the reinforcing fabric. Plastering the mortar onto the Steeltex and bonding it thoroughly to the brick provides a reinforced 1-in. concrete slab as backing for the brick facing. E.J.V.

Chicago's clay producing centers. ANON. *Brick Clay Rec.*, **74** [3], 178–85 (1929).—Some of the features on Chicago clay products plants which are especially interesting to other clay products manufacturers are listed and described. These include the elimination of lime pebbles in the clays by using a fine grinder which reduces the clay to particles ${}^1/_{16}$ inch or less in size; application of a dragline for clay-winning; spraying 3 separate colors at the same time by use of the "H" machine developed by Arnold Hottinger of Northwestern Terra Cotta Co.; standard type of plant buildings; a tractor installation which does the work of 15 men; hot-air drier operated like a waste-heat drier; protective paints which are acid gas resisting; insulation material which is impervious to kiln gases; tunnel kiln firing hollow tile; modern art in terra cotta; advances in oil burning on Chicago plants; metal hoods over kilns to conserve heat for drying; mixing coal with clay for better firing; loading 4000 brick in 5 minutes with a patent loading tray; kiln building erected of solid steel sections; remodeling a terra cotta plant; square bottom tubs on pug mill and granulators; and hacking brick in arch units. E.J.V.

Chicago; consumer of clay products. ANON. *Brick Clay Rec.*, **74** [3], 186–88 (1929).—Chicago, embracing the largest common brick producing and terra cotta centers in the world, some of the most modern and largest face brick plants, and an excellent representation of up-to-date hollow building tile manufacturing plants, is a big consumer of clay products. In a great many of its buildings, clay products are the chief structural materials. The newest thing in building practice in Chicago is the use of color through the medium of terra cotta as a decoration on skyscrapers. E.J.V.

New clay developments. G. A. BOLE. *Brick Clay Rec.*, **74** [4], 262 (1929).—A new type of clay product is being developed in endeavoring to perfect an ideal hollow unit, which is light in weight, has greater structural strength, will not crack or spall when subjected to heat, is uniform in size, a good insulator, is sound proof, has good acoustical properties, a unit into which nails may be driven, and which may be sawed by a carpenter's saw. It was recognized that a compromise would be necessary between such things as fire resistance and strength. Strength can be increased by improved design of products, improved quality of raw materials, by addition of electrolytes, better pugging, and reduced lamination. Of major interest at the present time is the creation of

a light weight unit. In this work, however, it must be remembered that the passage of heat is in inverse proportion to porosity. The smaller and more regular the air spaces are, the better will be its insulation value. In studying the production of such a material, the thought of commercial operation was constantly kept in mind, and it was recognized that it was of great importance to mold the product first, without bloating, and to effect the bloating after the product had been molded. The simple production of pores can be controlled by chemicals to almost any degree in laboratory work. There are limiting factors, however, such as the properties which make the product valuable in construction. Experiments were made in bloating clay chemically, by fire, and also by shredding the clay before molding it to the product. The clay is shredded by extruding through a perforated die with holes about $^1/_{16}$ inch in diameter, permitting the shredded material to drop into a mold and shaking or jolting the mold to form a fairly compact piece. This gives the effect of matting, much like spaghetti would look if molded into a unitlike tile. In all this work the commercial angle is not lost sight of, and it is believed that commercial production of a light weight unit with the properties will eventually be worked out. E.J.V.

Manufacture of gray brick. L. P. COLLIN. Can. Dept. Mines, *Mines Branch*, **660**, 8 (1928).—A description of the process of manufacturing gray brick in Pa. is given. About 26 lbs. of MnO_2 is added to the clays for 1000 bricks to give the color to the fired bricks. The firing temperature is from cones 8 to 10. By using a strong reducing atmosphere at the end of the firing various shades of gray are obtained. (*C.A.*)

BOOKS

Scum on Clay Ware: Its Cause and Prevention. ELLIS LOVEJOY. *Tonind. Ztg.*, **52** [53], 1073–77 (1928).—The book is thoroughly abstracted. F.P.H.

Brickwork in Italy. Compiled by American Face Brick Assn. Reviewed in *Arch. Forum*, **50**, 1 (1929). 298 pp.—An attractive and useful volume on history and use of brick in Italy from ancient to modern times. Illustrated with 69 line drawings, 300 halftones, and 20 colored plates with a map of 12th Century Italy. Bound in linen $3.00, Morocco $7.00. E.P.R.

Brick, How to Build and Estimate. Compiled by Common Brick Mfrs. Assn. of America. Reviewed in *Arch. Forum*, **50**, 1 (1929). 96 pp., illustrated. Complete data on use of bricks. E.P.R.

PATENTS

Lightweight molded article and method. JOSEPH ALBERT BABOR AND WILLIAM LUDLOW ESTABROOKE. U. S. 1,693,015, Nov. 27, 1928. A molded article comprising exfoliated zonolite and a binder.

Brickmaking machine. DAVID J. STRICKLAND. U. S. 1,699,818, Jan. 22, 1929. In a brick machine, a rotary mold reversing device having a central partition and oppositely disposed chambers and ejectors working through the partition and a vertically movable pallet support arranged following the mold reverser, and a conveyer upon which the pallet is deposited.

Building tile. JOHN ALVIN O'DONNELL. U. S. 1,700,542, Jan. 29, 1929. A hollow building tile having a partition wall interiorly dividing the tile to provide air spaces, the partition wall having passages extending therethrough between its edges whereby to weaken the wall and permit of halving of the tile, and likewise provide mortar grooves in the face of the intact portion of the partition wall which then constitutes one end wall of each tile half, the walls defining the passages having grooves in their ends, two of the 1st-named grooves being located at the juncture of the partition wall with the inner and outer walls of the tile body and the walls of the passages next adjacent the inner and outer sides of the tile body having vertical grooves formed therein.

Chimney flue. RAYMOND J. MOTHS. U. S. 1,700,850, Feb. 5, 1929. A clay

chimney tile comprising a flue portion having a curvilinear wall and a shell portion having a rectangular wall, the walls being merged at all four sides of the shell portion to a thickness not exceeding the thickness of one wall.

Molding brick. L. D. OLIVER. Brit. 300,075, Dec. 31, 1928. A brickmaking machine molds clay in large blocks with V-shaped breaking-grooves, and then divides them automatically into smaller units.

Walls. E. J. FREWEN. Brit. 300,684, Jan. 9, 1929. A wall provided with buttresses and piers formed of alternate courses of single-width blocks and blocks which are wider than the wall blocks and interlock therewith and with each other by four ribs or tongues and four grooves to produce load-bearing joints without mortar except at the sides of the tongues. The lintels are formed of blocks of single or double width reinforced with rods and interlocked with the buttresses. For bonding cross walls, the ribs and grooves are shortened and transverse ribs are added. A bitumin course is laid on the lowest course.

Brick machines. C. WHITTAKER & CO., LTD., AND N. WHITTAKER. Brit. 301,650, Jan. 30, 1929. In a semiplastic brick machine, the feed hopper or shoot is formed with one or more inclined sides so as to widen downwardly and at the bottom is so arranged an approximately horizontal screw or other conveyer which delivers the material to a box arranged above the reciprocating slide carrying the feed carriage.

Refractories

A study of refractory blocks in a small experimental glass tank. W. L. PENDERGAST AND HERBERT INSLEY. *Jour. Amer. Ceram. Soc.*, **12** [2], 123–41 (1929).—Tests to determine the relative resistance of various types of refractories to the action of flowing molten glass were made in a small laboratory glass-melting furnace similar in shape and operation to commercial scale, continuous glass tanks. The results of tests made in nine runs of the furnace, each run continuing for approximately 30 days, are given. The resistance of the refractories to glass attack apparently does not depend entirely upon chemical composition and porosity of the refractories, but is probably related also to (1) the size of pores, (2) the relative composition of grog and bond, and (3) the degree of adherence between particles in the refractory.

Method and cost of mining magnetite in Mineville district, New York. A. M. CUMMINGS. Bur. Mines, *Information Circ.*, No. 6092, December (1928).—As shown on the Adirondack sheet of the geological map of N. Y. State, the Mineville district is situated within the Adirondack gneisses and Grenville limestone. The magnetite deposits occur in the gneissoid beds, and the principal ones dip to the southwest at angles of 20 to 30° from the horizontal. The report gives in detail, ore deposits, development systems, and mining methods with costs. Figures are given illustrating in detail such subjects as mine contour lines, transportation systems, hoisting and hauling equipment, stoping and loading with scrapers, etc. R.A.H.

Bauxite and aluminum in 1927. J. M. HILL. Bur. Mines, *Mineral Resources of the U. S.*, Part I, pp. 7–24 (1927).—In 1927 the bauxite output of the U. S. was 320,940 long tons, valued at $1,988,780, a decrease of 18% in both quantity and value as compared with 1926. Imports of bauxite aggregated 356,580 long tons, valued at $1,572,236, an increase of 27% in quantity as compared with 1926. A list of the producers as well as consumers of bauxite in the U. S. in 1927 is given. The location of both foreign and domestic mines is also given. The value of the new aluminum produced in the U. S. in 1927, $39,266,000, was 4% greater than that of 1926, and the value of the secondary aluminum, $23,469,600 was 2% less than in 1926. Sections are given on markets and prices, metallurgy of aluminum, foreign aluminum industry, aluminum salts and cements, and aluminous abrasives and refractories. R.A.H.

Examination of low-grade bauxite with particular reference to flotation. B. W. GANDRUD AND F. D. DE VANEY. Bur. Mines, *Report of Invest.*, Serial No. 2906, December (1928).—During the past 2 years an investigation of the physical characteristics of low-grade bauxite has been carried on at the Southern Experiment Station of the U. S. Bureau of Mines. Special attention has been given to the possibility of applying commercial methods of concentration to low-grade bauxite. The concentration of an ore may be considered as the process of removing objectionable impurities. The objectionable impurities in bauxite are mainly silica and iron. Titanium is usually present in bauxite, but hardly ever in such quantities as to make the ore unsuitable for commercial uses. The investigation of low-grade bauxite has been made, therefore, with special reference to the possibility of removing excessive quantities of silica and iron. The physical characteristics and mineral constituents of low-grade bauxite, concentration of bauxite, and commercial possibilities of flotation of high-silica bauxite are discussed. The report is summarized as follows: (1) two American fields are recognized: the Arkansas and the Appalachian; (2) at present over 90% of the bauxite produced in the U. S. comes from the Arkansas field; (3) low-grade nature of bauxite from the Appalachian field accounts for the small production; the samples examined were primarily from this field; (4) in the 35 samples examined, float and sink fractionations with heavy liquids showed that many of these contained contaminants with such minute dissemination that physical processes of separation were impossible; (5) samples which were not too soft and claylike and were not too badly disseminated yielded fair results in small scale flotation tests; (6) sodium sulphide and oleic acid were required as flotation reagents. R.A.H.

Bricks for galvanizing furnaces. ANON. *Brit. Clayworker*, **37** [440], 336–37 (1929).—The fire brick used for constructing the furnace walls need not be of specially good quality, but silica brick should not be used as the conditions present cause ready spalling. The defects in galvanizing furnaces are seldom due to the quality of fire brick used, but are mainly due to faults in design. Attempts to use pots made of fire clay have not proved wholly satisfactory. R.A.H.

Blast-furnace developments in 1928. H. A. BERG. *Blast Fur. Steel Plant*, **17** [1], 67–68 (1929).—An interesting development is the production on a commercial scale of bricks for blast-furnace linings by firing in a reducing atmosphere. It is claimed that the iron oxides are eliminated as such and that therefore their possibly dangerous presence as catalytic medium of disintegration of lining is eliminated. The increasing use of high-temperature cements in laying up fire brick is also noted. Hot-blast stove design and construction is still following general orthodox lines insofar as they are still of the regenerative type and with fittings of established use. Some interesting departures, however, as to detail design of checker work and design and arrangement of combustion chambers have been made. Two installations have been made with round- and square-checker openings of $4^3/_4$ in. and with $2^3/_8$ to $1^{11}/_{16}$ in. diagonal inserts put into the checker openings, giving exceptionally good results in lower stack temperatures, higher efficiency, and providing the possibility of very large heating surfaces in comparatively small stove shells. F.P.H.

Review of modern open-hearth practice. G. D. TRANTER. *Blast Fur. Steel Plant*, **17** [1], 69–74 (1929).—In the early history of the open-hearth process, the development of a suitable refractory presented a serious problem. Numerous difficulties were encountered and "breakouts" through furnace bottoms and banks were very common. These conditions have been greatly improved in recent years, and most "breakouts" are due to carelessness on the part of the furnace operators rather than to the failure of the refractories. Magnesite is the chief refractory of most open-hearth linings. Chrome is also a valuable refractory especially for facing tapholes, maintaining proper size and

shape of gas ports, and as a neutral bond wherever silica and magnesite brick adjoin. It may be used either in the form of ground chrome ore or as chrome brick. Dolomite and the various kinds of patented refractories are valuable as patching material especially to repair the damage caused by slag erosion. These materials fuse very rapidly and reduce the furnace delays usually necessary whenever magnesite is used. The use of these materials, however, is limited to the upper section of the lining, and it is questionable practice to use them on the flat section of the hearth. The effectiveness of the various refractories is governed largely by local conditions and to the particular grades of steel to which they are subjected. With the development of furnaces designed for higher rates of production, improvement in refractories must necessarily follow. This is particularly true of refractory brick used in furnace construction. These brick are not only required to withstand high temperatures, but also the scouring and fusing action of the high iron oxide. Experiments have been conducted with special brick made of highly refractory materials but owing to the prohibitive cost, they have not been developed beyond the experimental stage. F.P.H.

Progress in the refractories industry. J. SPOTTS MCDOWELL. *Blast Fur. Steel Plant*, **17** [1], 88–90 (1929).—A brief summary is given of the principal developments in the manufacture and use of refractories of various kinds. In plant practice there have been notable trends among which may be mentioned the increasing adoption of machine methods, and the general harder fired clay refractories. After several years of costly experimentation, machines for the manufacture of silica brick were developed; these are now in general use. More attention is being paid to uniformity of quality as well as of size and shape of all refractory brick. There is a definite trend toward the adoption of continuous tunnel kilns for firing the product. Within the past year no less than five such kilns have been put in operation in the refractories industry, and more will be constructed in 1929. The first tunnel kiln ever used in America for the firing of silica brick is now in operation at the East Chicago plant of the Harbison-Walker Refractories Co. It is of the Heinrich Koppers regenerative type, producer gas fired, and is about 500 ft. long. The use of high temperature cements has greatly increased within recent years. Several years ago, so many inferior cements were on the market, that all of them were viewed with more or less suspicion by many careful users. Under the stress of competition and the test of use, the poorest ones have fallen into disuse, and today most of the cements on the market possess a degree of merit for the purposes for which they are adapted; and some of them may be used with highly advantageous results. Plastic fire brick is another product of recent development. This is essentially a stiff mud, similar in composition to that from which large clay shapes are manufactured. Its most general use consists in making repairs, or in filling spaces which would otherwise require intricate brick shapes. There is a growing realization of the great value of the current tests for refractories for the purpose of control of quality to insure uniformity of product, and of their serious defects and limitations when used in an endeavor to determine the suitability of a refractory material for given service conditions. As control tests they detect variations in the properties of the raw material or product and are therefore of value. There is rarely a definite correlation between the results of laboratory tests on brick and the service which they give under specific conditions; until such correlation is established the value of specifications for refractories will be limited. F.P.H.

Alumite, a new product of interest to the enamel industry. ANON. *Ceram. Ind.*, **12** [2], 254 (1929).—The outstanding property of "Alumite" is its freedom from any tendency to grow, swell, dissociate, or change allotropic or crystalline form under varying furnace atmosphere and service conditions. The merits of its use in gas-fired installations is quite apparent. F.P.H.

Graphite: occurrence and use in the glass industry. HUGO KÜHL. *Glasshütte*, **25**, 491–92 (1928); *Tonind. Ztg.*, **52** [55], 1132 (1928). F.P.H.

Fuel lost during loading and unloading period when clayware is fired in ring furnace. K. O. SCHULZ. *Tonind. Ztg.*, **52** [45], 914–15 (1928). F.P.H.

Design of brick crucible furnaces. WALTER J. MAY. *Mech. World*, **85** [2194], 54–55 (1929).—Many mechanical crucible furnaces are now in use, but the old form of natural-draft pot furnaces is also still employed and for fairly well-defined reasons will continue to be used. Details of construction are given. E.P.R.

Aluminium and bauxite. ANON. *Mineral Ind.*, **36**, 11–27 (1927).—Fifteen years ago France and the U. S. produced almost all of the world's supply of bauxite, but since that time extensive deposits of high-grade bauxite have been developed in other countries, and the production is now trebled, with the new producing areas furnishing over one-half the output. Due to the recent rapid growth in the demand for aluminium, aluminous abrasives, aluminous cement, and aluminium salts, the world's production of bauxite is now more than 1,600,000 T. a year. Fifteen years ago the production was a half-million tons, with France supplying 60% and the U.S. 40%; at the present time these two sources account for only about one-half the production. E.P.R.

Chromium. WILLIAM DRUMM JOHNSTON, JR. *Mineral Ind.*, **36**, 74–80 (1927).—Chromite, which is the commercial source of all chromium products, has the composition $FeO \cdot Cr_2O_3$. The pure mineral contains 68% Cr_2O_3, but the content of the marketed material ranges between 35 and 55%. The greater part of the chromite imported into the U.S. is used in the manufacture of chrome and chrome-nickel steels, and as the principal constituent of chromium refractories. Chromium refractories for open-hearth furnaces continue to replace magnesite, but only because of advantage in price. E.P.R.

Magnesite. HUGH M. HENTON. *Mineral Ind.*, **36**, 373–81 (1927).—A detailed description of preparation and uses is given. E.P.R.

Titanium and zirconium. J. W. MARDEN. *Mineral Ind.*, **36**, 584–90 (1927).—No new uses of titanium or its compounds have been suggested during 1927. The principal consumption has been in the manufacture of paint pigments, enamels, ferro-alloys, etc. Stansfield and Morrison have studied the fusibility of blast-furnace slags containing titanium (CaO, SiO_2, Al_2O_3, TiO_2, Ti_2O_3). The formation of refractory compounds of titanium under conditions existing in the blast furnace are shown and these authors believe that a clear understanding of the treatment of titaniferous ores will soon be had. Although there have been practically no new uses suggested for zirconium or its compounds during the past year, its use as a refractory (zircon or zirkite) continued to grow, and the rather deep rooted prejudices to it are being slowly overcome as its properties become better known. Lee in describing the mineralogy of hafnium gives a list of over forty minerals of zirconium, their chemical formulas, and zirconium oxide content. Zircon occurs in the U.S. in commercial quantities in but three localities, western N. C., Pablo Beach, Fla., and Ashland, Va. E.P.R.

Bonding of silica brick. W. J. REES. *Refract. Jour.*, **4** [40], 104–109 (1929).—The bonding of silica brick has for a long time proved to be a problem. The bond fulfils two important functions: (1) since ground silica rock possesses little or no plasticity or bond of itself, it is desirable to add to brick batches something which will give strength to the green brick, thereby insuring safety in handling; (2) to impart good strength to the fired brick. A completely soluble bond is attractive both theoretically and practically because the best bond is that which is most easily distributed over every fragment of the crushed rock in the batch. A slip or emulsion shows a tendency to segregation. The principal soluble bonds are (1) silicate of soda, which gives good green strength and in firing reacts with the silica in the batch to form a fairly satisfactory brick, having the

disadvantage of high alkali content; (2) the use of ammonium alum, a compound of ammonium sulphate and potassium sulphate, proves satisfactory in giving green strength to the brick, and firing removes the ammonium sulphate leaving aluminium sulphate which produces a fairly satisfactory bond; (3) the use of aluminium sulphate alone has also been patented; (4) calcium chloride is another soluble bond, but it has the disagreeable characteristic of liberating hydrochloric acid on heating, and this often affects the kiln lining A disturbing feature of soluble bonds is that they tend to be concentrated on the skin of the brick, leaving the center rather weak. After firing, the skin contains a high proportion of glass and the bricks are very liable to spall. There are certain soluble and insoluble organic materials which have been used as bonds with more or less success. For instance, dehydrated tar, dextrin, flour in the form of starch paste, and a by-product from the treatment of wood, which is used extensively in Germany under the name of Silikanite and whose more general name is sulphite lye residue, are used. Organic bonds such as these are completely removed when the bricks are fired. The green strength imparted by lime or clay bond is increased markedly by the addition of very small proportions of organic binder, of which as little as 0.05% has been found to be sufficient. Lime bond can be used in two forms: (*a*) as a putty prepared by slaking quick lime to form a paste or putty which is then added to the batch in measured volume or in known weight; (*b*) an emulsion of known specific gravity prepared by carefully slaking quick lime and then gradually adding water with constant stirring until a concentration of about 10% is reached. More concentrated emulsions tend to be less uniform but the use of emulsions is regarded as preferable to the use of putty. In America hydrated lime is coming into common use for the bonding of silica brick. This is merely mixed with water and possesses advantages in convenience only. The proportion of lime used in bonding silica brick varies with the type of brick required and with the type of raw material used. Thus the purer forms of silica rock require the higher lime bond, as is shown by the fact that if a batch containing 68½% silica is bonded with 1% of lime the result is poor, and it is apparent that 1½ to 2% of lime is necessary. Ganisters can be satisfactorily bonded with as little as 1% lime, because they contain small amounts of other impurities which assist the bonding action. The effects of a lime bond are interesting apart from a consideration of mere binding characteristics. In the first place lime exerts a bleaching effect on the brick due to formation of calcium ferrate. The color of the silica brick therefore is no criterion of quality since brick possessing good color may owe this to rather high lime content and may in consequence possess poor durability in service. In the kiln, lime and silica with a small amount of alumina (present as feldspathic matter) combine to form a calcium aluminium silicate, the composition of which is approximately: lime 23%, alumina 15%, silica 62%. The bond plays a very important part in assisting the conversion of silica to forms of tridymite and cristobalite. The bond has some useful effect in increasing the percentage of tridymite present in a brick. This is important because cristobalite is troublesome inasmuch as it has a high rate of expansion at a low temperature, and brick containing high proportions of cristobalite must be the subject of very special care when furnaces embodying them are heated up. A brick containing almost 100% cristobalite would show an expansion of over 1% when heated to a temperature as low as 270°C. The utmost precaution is necessary therefore when heating furnaces built of silica brick unless they contain a high proportion of tridymite which is far less troublesome and has a more even and regular expansion. Clay-bonded brick are a little more fragile than lime-bonded, but it has been found that the clay bond can be used successfully even for the manufacture of intricate shapes. Commercial tests showed that the clay-bonded brick possessed no superiority over lime-bonded, except that the spalling tendency appears to be a little less under the same conditions of grading and firing of the brick. The grading of the batch has a considerable

effect on the strength of the bond and of the fired brick. During the war, Le Chatelier showed that by increasing the proportion of exceedingly fine material in the batch there was a definite increase in the mechanical strength of the brick. The presence of iron oxide in silica brick may have some disadvantages, but for most metallurgical purposes $2^1/_2\%$ in a silica brick leads to an increased durability. Iron oxide added to brick batches produces already seasoned brick. On this point some very interesting conclusions can be drawn from an examination of the brown spots which are to be found in many silica brick. These spots are probably due to metallic iron included in the batch as a result of the wearing of the machinery used for grinding. In micro-section such spots show an appreciable proportion of tridymite, the porportion increasing from the outside of the spots to the center. The iron oxide seems to encourage the formation of tridymite, and it may therefore be described by the chemist as a catalyst. E.P.R.

Silica and magnesia crucibles. ANON. *Refract. Jour.*, **4** [40], 109 (1929).—The production of silica and magnesia crucibles in the induction furnace has been achieved in the laboratory of the Pacific Experiment Station of the Bureau of Mines, Berkeley, Calif. E.P.R.

Nontechnical description of spalling action. STUART M. PHELPS. *Refract. Jour.*, **4** [40], 119 (1929); for abstract see *Ceram. Abs.*, **7** [11], 761 (1928). E.P.R.

Refractory manufacturers combine. ANON. *Glass Ind.*, **10** [2], 48 (1929).—Six manufacturers of fire brick and other refractories operating 15 plants with an annual capacity of 155,000,000 bricks have been organized into the North American Refractories Co., with J. D. Ramsay as president; E. M. Weinsfurtner, J. M. McKinley, H. S. Schleicher, H. J. Cavender, and E. H. Gartrell, vice presidents; H. E. Spuhler, vice president and treasurer. The companies combining are the Ashland Fire Brick Co., Crescent Refractories Co., Dover Fire Brick Co., Elk Fire Brick Co., Farber Fire Brick Co., and the Queens Run Refractories Co. E.J.V.

Determination of iron oxide and titania in clay refractories. W. R. KERR AND E. B. READ. *Pottery Gaz.*, **54** [620], 285 (1929); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [11], 846–51 (1928); see also *Ceram. Abs.*, **7** [12], 864 (1928). E.J.V.

Physical properties of glass tank-block refractories. A. E. MACGEE. *Pottery Gaz.*, **54** [620], 295 (1929); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [11], 859–67 (1928); see also *Ceram. Abs.*, **7** [12], 831 (1928). E.J.V.

Graphite in Ontario and Quebec. HUGH S. SPENCE. Can. Dept. Mines, *Mines Branch*, No. **687**, 8–11 (1928).—Only 2 graphite mines and mills were in operation in 1926, one near Calabogie, Ont. and the other near Guenette, Que. Flow sheets of both mills are shown. Milling methods have recently been improved by the introduction of flotation methods. (*C.A.*)

Kaolinic refractories and their properties. MARK J. TERMAN. *Heat Treating and Forging*, **14**, 642–43 (1928).—Processing a kaolinic material by a new method, a recrystallized refractory brick is obtained having a maximum uniformity of quality and size. Its ratio of SiO_2–Al_2O_3 is the same as that of other clays; its melting point is 3200°F in an oxidizing and 3165°F in a reducing atmosphere; up to 2900°F it has no permanent volume change and only a slight shrinkage up to 3000°F its average coefficient of expansion is 242×10^{-8}; it shows unusual resistance to spalling, does not "grow" under continued exposure to heat, and has unusual load-bearing capacity. Some applications are outlined. (*C.A.*)

Microstructure of silicate bricks. N. N. SMIRNOV. *Trans. State Expt. Inst. Silicates* (Moscow), **20**, 5–18 (1926).—Microscopic observations and chemical analyses show the presence of crystalline Ca hydrosilicate in silicate brick. The crystalline form of the cementing substance obtained is the cause of the strength of the brick. For this reason all the operations in the manufacture of silicate brick should be directed toward a maxi-

mum formation of the crystalline cementing substances. The following might be done to attain this end: (1) The lime should be ground as fine as possible. The fineness of the material serves as centers of crystallization. (2) The lime should be completely slaked. The sand and lime should be admitted into the drum simultaneously and in equal proportions. (3) Maximum pressure is desirable for the close contact of the lime with the sand. (4) The steaming should be continued as long as possible in order to obtain a large, granular crystalline mass and a maximum amount of soluble SiO_2. The microscopic observations are illustrated. (*C.A.*)

Characteristics of refractories. J. F. HYSLOP. *World Power*, **10**, 253 (1928).—A review. (*C.A.*)

BOOK

Industrial Carbon. C. L. MANTELL. D. VAN Nostrand Co., N. Y., 1928. 410 pp. $4.50. Reviewed in *Min. and Met.*, **10** [266], 102–103 (1929).—M., a professor in Pratt Institute, Brooklyn, N. Y., has enlisted the aid of many people actively engaged in the carbon industries with the result that each chapter is in effect produced by a specialist in that subject, without the usual drawbacks of lack of balance and of coherence when a book is written by a number of persons. Since the book takes in all forms of carbon it deals with some that are outside the mineral industry, indicating the relative position of the different forms. There are 29 chapters but some of them deal with more than one form of carbon; *e.g.*, Chapter 19 deals with metal absorbent chars, and has been reviewed by A. W. Allen. M.'s treatment of graphite, diamonds, carbon black, electrodes, carburizers, and welding carbons will be of most interest to men in the mineral industry. F.P.H.

PATENTS

Solid cast refractory articles. GORDON S. FULCHER. U. S. 1,700,288, Jan. 29, 1929. The method of making solid cast refractory articles which includes pouring molten refractory material into a mold, allowing a portion of the material to solidify and shrink, and feeding additional molten refractory material into the mold to compensate for the shrinkage of the material first poured.

Brick checker work. JULIUS M. BOCZEK. U. S. 1,700,398, Jan. 29, 1929. Brick checker work construction comprising a plurality of spaced parallel vertical longitudinal walls, and spaced parallel end and intermediate transverse vertical walls disposed at right angles to the longitudinal walls to form vertical flues extending through the checker work, each longitudinal wall being composed of horizontal courses of brick, each intermediate transverse wall embodying vertically aligned horizontal supporting brick laid across alternate courses of the longitudinal walls in spaced opposed relation, and further horizontal brick extending between and supported at their ends by alternate pairs of opposed supporting brick to leave communicating passages between adjacent flues.

Forming silica glass articles. F. CARPMAEL. Brit. 301,117, Jan. 16, 1929. The patent relates to a process for making hollow articles of quartz and consists in inflating the fused mass against the wall of the furnace after removal of the heating elements, the furnace serving as a mold to shape the articles. The apparatus comprises a furnace fitted with a removable cover, terminals being provided for supplying current to a resistance element. Tongs, each of which can close around the element, are fitted to the upper and lower parts, respectively, of the furnace. In use, the device is filled with sand and a tubular blank is formed by the heat of the element in the known way. When the blank is sufficiently formed, the element, the terminal, and the cover are removed and an air pipe is inserted in the upper end of the blank. The tongs are closed so as to grip the blank on the air pipe, the terminal is removed to permit the unmelted sand to run out of the mold, and the tongs are closed so as to close the lower end of the blank. Air is then blown into the blank in order to inflate it against the wall of the furnace. The proc-

ess may also be used with a blank which is formed with one end closed, as described in Brit. 280,291. See *Ceram. Abs.*, **7** [4], 239 (1928).

Terra Cotta

Tests of terra cotta faced walls. ANON. Bur. Stand., *Tech. News Bull.*, No. 140, 171–72 (1928).—The Bureau in coöperation with the National Terra Cotta Society has just completed a second series of tests on terra cotta faced walls. The purpose of this work is to determine the best method of setting terra cotta ashlar on buildings. The test walls were $4^1/_2$ by $7^1/_2$ ft. and included different types of construction now in vogue in different parts of the country. The strengths of the walls were determined under different types of loading. It appears from the test data that the filled terra cotta facing adds considerably to the strength of the walls. It was also found that the strength of walls built with 8-cell ashlars is greater than those built with 6-cell ashlars. R.A.H.

Terra cotta used for hotel. ANON. *Arch. and Bldg.*, **61** [1], 5 (1929).—A new 800-room hotel, New York City, is finished in a buff-colored brick with the first two stories of ornamental character. In the vestibule polychrome tile is used in designed panels for ornamentation. E.P.R.

Selling plant policies to key men. ANON. *Brick Clay Rec.*, **74** [2], 94–96 (1929).—The Progress Club at the Northwestern Terra Cotta Co. was organized "to promote the progress and development of the manufacture of terra cotta to the highest possible degree, to secure the greatest possible coöperation between the various factory departments, and to give each department a better understanding of the problems of the other departments." It has lived up to its aims to a remarkable degree. E.J.V.

White Wares

Absorption of two earthenware bodies and their resistance to crazing in the steam test. E. P. WRIGHT. *Jour. Amer. Ceram. Soc.*, **12** [2], 118–22 (1929).—An ivory and a white earthenware body fired in different positions of periodic and tunnel kilns and maturing to various absorptions were subjected to autoclave steam treatments at the pressures of 100 and 150 lbs. per sq. inch. The ivory body resisted the crazing induced by this test for absorption from 7 to 8% in the 100-lb. pressure treatment. The white body withstood the destructive effect up to an absorption of 8.5%. Within a narrow range, thorough glost firing had some effect in increasing the resistance. In the 150-lb. test, the critical resisting absorption was lowered to 6% for each body.

Manufacture of Westinghouse porcelain insulators. ANON. *Ceram. Ind.*, **12** [2], 202–12 (1929).—The manufacture of dry-pressed, plastic-formed, and cast electrical porcelain at Derry, Pa., is described. The raw materials are gathered from hoppers located over a track on which a batch car is run. Butterfly doors permit the effective release of the raw materials which are weighed on a locked scale. After weighing, the charge is dumped into a hopper which feeds a bucket elevator and conveys the material to the ball mills. The clays are milled first for 45 min. then the flint and feldspar are added, and the entire mass is milled for an additional 30 min. The slurry is then passed through two screens, the first being 30-mesh, and the second 60-mesh. In this milling process, the correct amount of water is added, taking into consideration the moisture content of the raw materials, principally of the ball clay. The blunged materials pass over magnets and directly into the agitators that supply the circulatory casting system. The slip in the agitator is tested daily, and the salts are carefully calculated. When the slip is ready for casting, it weighs 60 ounces to the quart. Casting is done in the usual manner, and cloths are placed over the mold cores which ease the release of the cores. The mold cores are pulled 12 to 30 hours, depending upon the size of the piece and the

appearance of the cast. After the cores are withdrawn, the piece stands for several hours, then the molds are removed and the pieces set on trucks and sent into a drier which is kept at 140°F. The body preparation procedure for the plastic and dry-press ware is the same, but differs somewhat from that used in the processing of the cast ware. The flint and feldspar are milled in three 6 ft. 8 in. ball mills for about one hour. During this time the clay is blunging. When the mill has run its required number of revolutions an air line, carrying a pressure of 15 lbs. per sq. in., is attached and the slurry is lifted to the blunger which is located above the mills. The entire mass is blunged for one-half hour and then run through the rough agitator for an hour for further mixing. From this agitator the slip passes over a double screen, the first being 100- and the second 140-mesh, then over magnetic separators and into the fine agitator, which contains a day's supply for the presses. In blunging and agitating, the water is heated to 90°F which speeds up the process; and the specific gravity and viscosity of the slip which is to be filter-pressed is checked daily. F.P.H.

Ceramic development in the electrical industry during 1928. HOBART M. KRANER. *Ceram. Ind.*, **12** [2], 214–15 (1929).—The trend toward higher voltages in power transmission has resulted in larger apparatus. As a result, 6-ft. bushings glazed together in sections can now be cast by the use of special molds and casting. This reduces to a minimum the possibility of dielectrically defective joints and at the same time increases the strength and reliability of bushings which are used on transformers and circuit breakers. Radio interference is sometimes caused by corona from the line and tie wires on pin-type insulators. A conducting layer of metal applied by ceramic methods reduces the interference from this cause. The tie and line wires make better contact with the porcelain through this coating of metal on the heads of the insulators and it has been found that about 50% higher voltages can be carried on a line of insulators so treated without these discharges taking place between the wires and shell. The porcelain-to-metal seal is a recent notable development and is important in that valuable insulating joints are produced. Such joints are vacuum and oil tight. They are so strong that in test, the metal parts not only adhere firmly enough to remove pieces of glaze, but remove large pieces of porcelain when the joint ruptures. The importance of this development can be seen when one realizes that it has made possible a perfect seal in the large mercury arc rectifiers now made and assists materially in greater and more efficient underground current distribution through the use of a new cable joint. This latter consists of an occasional joint of porcelain in the lead cable carrying high-tension lines. Many other applications of this joint are in process of development for, since it is remarkable for its strength and its being gas tight, many insulated members in all kinds of apparatus can be fastened more firmly and satisfactorily by this means than has been done by any other. F.P.H.

Ohio setting pace in pottery business. ANON. *Clay-Worker*, **91** [1], 71 (1929).—Seventy-four per cent of all pottery made in the United States is manufactured in four states: Ohio, N. J., W. Va., and Pa. They rank in the order named, Ohio alone manufacturing about $39,000,000 worth, or more than one-third of the nation's total The pottery business and employment in these states is analyzed as follows:

	Employees	Value of output
Ohio	13,876	$39,896,000
New Jersey	7037	24,157,000
West Virginia	4127	19,500,000
Pennsylvania	3748	7,343,000

The total value of all pottery manufactured in the U. S. is about $111,000,000 a year, based on government figures from 1919 to 1925. E.J.V.

Perfects new pottery. C. L. SEBRING. *Clay-Worker*, **91** [1], 78 (1929).—A new chinaware, with the color pigment mixed in the clay instead of the glaze, is announced. This new ware was on display at the Pittsburgh pottery show held recently and created much interest. E.J.V.

Effect of silicate of soda on casting slips. K. SILK AND N. D. WOOD. *Pottery Gaz.*, **54** [620], 272–73 (1929).—Comparative effects on an earthenware slip of varying soda-silica ratios in silicate of soda are outlined. Silicate of soda is probably one of the most important of the group of reagents used in slip casting, and is in many ways an unusual substance. Unlike most substances, it has no definite composition. Silicates are manufactured with a soda-silicate ratio which may vary considerably. In dilute solution, silicates with a lower proportion of silica than is necessary to produce the bisilicate, hydrolyze in such a way that the final products are caustic soda and sodium bisilicate, $Na_2O{\cdot}2SiO_2$. The lower the proportion of silica, the more complete the hydrolysis. On the other hand, silicates containing an excess of silica beyond the bisilicate ratio are, to that extent, composed of colloidal silica. As to the physical properties of the silicates, the high-silica silicates are thicker, more viscous than the high-soda silicates, and when concentrated above 70% of solids, become jellylike and can be bounced like a ball. High-soda silicates, when concentrated above 60%, only become increasingly viscous. The fact that silicate of soda has such unusual properties, and is so important in the production of casting slip, led to a desire to know how the variations in soda silicate ratio would affect the casting properties. The general effect of silicate of soda on the body is as follows: (1) the lime brought in with the flint, and originally present in the clays, is rendered inactive by the formation of insoluble calcium silicates; (2) part of the silica forms a protective layer over some of the clay grains; and the soda tends to deflocculate the whole. From such considerations, variations in the soda-silica ratio is found to have a marked effect on the casting qualities of ceramic bodies. The connection between casting and the fluidity of the slip had led to attempts to follow out the changes by means of fluidity measurements. Previous work by E. Kieffer, using Kemnitz kaolin and a wide range of silicates of soda, showed that the high-silica silicates are more active in thinning the slip than those in which the soda content is greatest. S. J. McDowell, using 2 soda-silica ratios, averages the results obtained with 5 clays. The high-silica silicate produces the greater "flowability," this is reached earlier than with the high-soda silicate. For casting, McD. recommended a mixture of 80% high-silica silicate and 20% soda ash by weight. S. R. Hind found that in viscosity experiments on a commercial casting body there is practically no difference in the relative fluidity produced by adding soda, either as silicate or carbonate, to the slip. The casting qualities and stability of the slips, however, differ greatly, according to the electrolyte added. This suggests that fluidity only gives a partial indication of the casting qualities. Bleininger and Hornung also found that in bodies consisting of feldspar, flint, and clay, the same results are obtained with carbonate additions as with silicate additions, except in one case, where the silicate appears to be more effective in increasing the fluidity. Considering the two sets of conclusions, Kieffer and McDowell working with straight clays of the china- and ball-clay type, found that the higher silica silicates are more effective in increasing the fluidity, while Hind, and Bleininger and Hornung, working with composite bodies, found that the fluidity is the same no matter how the soda is introduced. This suggests a difference between the behavior of a clay and a body to the silicate additions. The present experiments are designed to test the effect of varying soda-silica ratios on the fluidity of slip made from a commercial earthenware body. The results obtained led the experimenters to quite different conclusions from those arrived at by Kieffer and McDowell working with straight clays. One of the possible sources of difference between the straight clays and the composite body is the introduction of a small

percentage of free calcium carbonate with the flint. To test this, whiting was added to a typical china clay. (1) The same amounts of silicate of soda samples representative of the range were added to the china clay slip. The results were in opposition to those which had been previously obtained, but in agreement with the results obtained by others using straight clays. (2) 1.5% of whiting was sifted through a 200-mesh sieve on to the dry china clay, the whole being hand-mixed for 15 minutes and then blunged with the silicate of soda and water in the usual way. The flow-time by this means was considerably increased, but the comparative effects of the silicate samples were still the same as with the china clay, *i.e.*, the silicates that were richest in silica tended to produce greater fluidity than the silicates that were richest in soda. Fluidity showed a marked similarity between the results with the different silicates of soda. In every case, the majority of the deflocculation attainable was achieved at a concentration corresponding to 0.02% Na_2O on the dry body. Considered more closely, the indications were that increasing the proportion of silica in the silicate of soda slightly thickened the slip. This was most marked with the higher proportions of added alkali. As the fluidity of slips containing clay was known to be influenced by a wide variety of mechanical conditions incident to its original state and method of preparation, it was thought possible that different results would have been obtained if the body had not been dried before use. A series of tests designed to probe this possibility reveal no important difference. The effect of an increasing soda-silica ratio on an earthenware body is found to be the reverse of the effect on a china clay. Both these conclusions are substantiated by the work of previous investigators. The presence of free calcium carbonate does not, according to the tests, account for the difference. E.J.V.

Porcelain manufacture in Canada. ANON. *Pottery Gaz.*, **54** [620], 293 (1929).—The International Clay Products Co., Ltd., of Estevan, Sask., has decided to undertake the manufacture of porcelain from clay deposits available in that province. Extensive experiments were made by the company and by the Ceramics Department of the University of Saskatchewan. Methods have been found by which Saskatchewan clays can be handled for the production of porcelain in kilns heated by Saskatchewan lignite coal, also available at Estevan. The lignite briquetting plant in this locality was recently acquired by a British company which has expended $600,000 on the improvement of the plant, and expects to secure a production of 100 T. per day by next spring. E.J.V.

Pottery production in U. S. ANON. *Pottery Gaz.*, **54** [620], 294 (1929).—The value of whiteware or semiporcelain products made in American potteries in 1927 declined as compared with 1925, while value of stoneware, yellow ware, and Rockingham ware increased in the same period. The value of the production of red earthenware declined from 1925 to 1927. Whiteware, which includes cream color, white granite, semiporcelain, and vitreous porcelain, had a total value, as reported by the manufacturers, of $32,475,757 in 1927, as compared with $32,498,573 in 1925. Of the 55 establishments reported for 1927, 34 were located in Ohio, 7 in W. Va., 3 in Pa., 2 in Calif., 2 in N. J., and one each in Ill., Ind., Md., Mass., Mich., Tenn., and Va. In 1925, the industry was represented by 59 establishments. The decrease to 55 in 1927 was due to the fact that one establishment was reported out of business, two reported commodities other than whiteware as their principal products, and one reported products of less than $5000 in value.

E.J.V.

Feldspar. ARTHUR S. WATTS. *Mineral Ind.*, **36**, 203–205 (1927).—The feldspar situation in the U.S. is reviewed. The crude feldspar sold or used by producers in the United States in 1927 amounted to about 202,497 long tons, valued at $1,424,755. Except for minor purposes, feldspar is prepared for use by grinding. Only a very small portion is ground by users. Some of the older plants are being modernized to lower cost of grinding. The output of mines and capacity of mills far exceeds present market de-

mands. The quality has steadily improved and is uniformly superior to that of former years. The feldspar pulverized in closed-circuit with air classification is in some cases lower in extremely fine-ground material than that from the old periodic mills. The amount retained on 200-mesh sieve is generally lower than in the past. Twenty commercial feldspars from all producing districts of the U.S. and Canada were tested. Chemical analyses were furnished by the shippers. Pulverization as indicated by residue on 200-mesh sieve, temperature, rate of deformation and behavior in semivitreous and vitreous bodies were investigated. There is no apparent relationship between chemical analysis as furnished and physical behavior of the feldspars. This is possibly due to errors in alkali determination. The data developed indicate that the translucency and vitrification of the product are influenced more by the fusion behavior than by the fusion temperature of the feldspar. Feldspars which alone fuse at low temperatures are in many cases less active as vitrifying agents than those which fuse at somewhat higher temperatures. This observation refers to the feldspars slightly higher in soda than the normal potash feldspar of commerce. For use in glazes, the feldspar which contains an excess of soda is undoubtedly superior. The composition, initial fusion temperature, rate of fusion, and degree of pulverization are all so important that no feldspar can be chosen as a body constituent without careful preliminary study and test in body combination, and this must be understood by both producer and consumer.

E.P.R.

Refractoriness of earthenware glaze frits. E. LEONHARDT AND E. ZSCHIMMER. *Keram. Rund.*, **36**, 441–45, 467–70, 481–83, 508–10, 540–43 (1928).—Two glaze frits with the Seger formulas were used in a series of experiments to determine softening points with various heat treatments and with other varying conditions.

Frit I			Frit II		
0.31 PbO 0.23 CaO 0.07 K_2O 0.39 Na_2O	0.22 Al_2O_3	2.50 SiO_2 0.75 B_2O_3	0.34 PbO 0.24 CaO 0.42 Na_2O	0.45 Al_2O_3	5.37 SiO_2 1.75 B_2O_3

Melts were made in saggers in a porcelain kiln, and in clay and platinum crucibles in a Fletcher gas furnace. To determine the amounts of volatilization of B_2O_3, PbO, and Na_2O in the three methods of melting, analyses were made of the raw materials and of the finished frits and compositions as calculated from the batch formulas were compared with compositions obtained from analyses of the frits. Pyramids similar in size and shape to Seger cones were made of the frits which had been crushed to different grain sizes and bonded with an organic binder. The pyramids were heated at the same rate to determine the effect of grain size on the cone deformation temperature. In general, the cones of smaller grain size deformed at the higher temperature in spite of the fact that the cones with smaller grain size have the greater apparent specific gravity. A theoretical explanation based on the assumed arrangement of the particles and the interstitial air spaces is given. It was found that such interstitial air spaces in cones made of powdered frit introduced serious errors into the determination of deformation points and that cones made by casting the molten frit into molds were more satisfactory and gave results reproducible within about ± 2°C when the heating rate was carefully controlled. The temperature at which a cone of the standard shape and size cast from the molten frit deforms with a given heating rate is a constant for the material. The deformation temperatures for different heating rates were as follows:

	2°C/min.	6°C/min.
Frit I	691°	720°
Frit II	710°	759°

The effect of the addition of each of the oxides B_2O_3, PbO, Na_2O, SiO_2, Al_2O_3, and CaO on the deformation temperatures of both frits was studied. B_2O_3, PbO, and Na_2O lowered the deformation temperature, Na_2O having the greatest and B_2O_3 the least effect. SiO_2, Al_2O_3, and CaO raised the deformation temperature, Al_2O_3 having the greatest and SiO_2 the least effect. H.I.

Iron spots on fine ceramic products: cause and prevention. A. OTREMBA. *Keram. Rund.*, **36**, 466–67 (1928).—While iron may be present originally in the clays or other raw materials used in ceramic products, a frequently overlooked source is iron-containing water used in preparing clays. Iron compounds in the water may be precipitated upon algae during aging of the clays thus producing iron spots. Water may be purified by precipitating the iron as hydroxide or by filtering. H.I.

Electric conduction in hard rubber, Pyrex, and fused and crystalline quartz. HUBERT H. RACE. *Jour. Amer. Inst. Elec. Eng.*, **47**, 788–91 (1928).—Polarization and conduction both result in the conversion of electric energy into heat, producing local and general heating, which may be contributing causes to the progressive deterioration and final breakdown of the insulation. The constant potential method described provides a means of studying the inherent voltage-current-time relations which may be masked, where alternating applied potential is employed. The object of the tests was to determine curves of electric current flow as functions of time, through certain solid dielectrics, after constant potential has been either applied to or removed from opposite faces of a flat plate of the sample. Means of making tests and experimental results on 4 materials are given. Experiments were conducted with an air-gap and with intimate contact. Several curves are included. Peculiar reversals are noted in the charge and discharge curves for fused quartz. (*C.A.*)

PATENTS

Method of casting. ARTHUR O. AUSTIN. U. S. 1,693,429, Nov. 27, 1928. The method of casting comprising the steps of filling a mold of porous material with a ceramic ware slip, placing hydraulic pressure on the slip within the mold to facilitate passage of water from the slip to mold, permitting a layer of ceramic material to be deposited on the inner wall of mold, removing the slip from the mold, and filling the interior of the mold with a fluid under pressure to compress the deposited layer and render it more nearly uniform.

Making insulators. KENT A. HAWLEY. U. S. 1,699,063, Jan. 15, 1929. The method of assembling a skirt upon the body of a porcelain insulator while in plastic condition, consisting in placing the skirt about the body, and causing union of the material at the joint.

Raising the flash-over voltage of bushing insulators. ARTHUR O. AUSTIN. U. S. 1,699,342, Jan. 15, 1929. In combination, a tubular insulator, a conductor extending through the insulator, a support secured to the exterior of the insulator between its ends, a dielectric member of fragile material surrounding the insulator adjacent the outer face thereof, the member being U-shaped in cross-section and open at one side to permit assembly of conducting material therein after formation of the dielectric member, and conducting material within the dielectric member arranged to leave the inner walls free to move by expansion or contraction, the conducting material within the dielectric member extending to a position between the support and one end of the insulator, the closed end of the dielectric member being disposed between the conducting material within the dielectric member and the end of the insulator.

Insulator for bridle wires. BENJAMIN JOHNSON. U. S. 1,700,166, Jan. 29, 1929. An insulator adapted for use with bridle wires, the bridle wires having a bared portion and an adjacent portion with insulated covering, a tubular chamber for the insulator a circumferential flange and a cap for engaging the flange and rendering the chamber

water-proof, the bared portion of the bridle wire extending through the cap and being secured thereto, and the insulated portion terminating in the chamber to prevent moisture being further carried along by capillary attraction, and spacing means positioned within the chamber portion and above the bottom of the insulator for retaining the bridle wire in vertical position and free from contact with the bottom of the insulator, the spacing means providing with the vertical wall of the tubular chamber a sheltered recess to interrupt the exterior conductivity of the insulator under wet weather conditions to restrict the leakage of current between the elements of the insulator.

Insulator. CHESTER S. GORDON. U. S. 1,701,561, Feb. 12, 1929. An insulator comprising a body of dielectric material having an internal opening into which a pin may be inserted, the outer surface of the body being screw-threaded, a shell of conductive material adapted to coöperate with the screw threads and to be screwed into position over the outer surface of the body, the shell being formed with a shoulder to form a seat to which the line conductor and tie wire may be fastened, and means extending outwardly above the seat to prevent moisture from working in between the dielectric body and the shell.

Insulator. CHESTER S. GORDON. U. S. 1,701,562, Feb. 12, 1929. (1) An insulator comprising a body of dielectric material having an inner opening to receive a supporting pin, a relatively small buttonlike structure on the top of the body having a grooved portion to which the line conductor and tie wire may be secured, the grooved portion being of a diameter not materially greater than the supporting pin, an umbrellalike structure at the upper side of the dielectric body for protecting a portion of the outer surface of the body from moisture, and a surface of conductive material extending from the outer edges of the umbrellalike structure to and over the button, the umbrellalike structure with its metallic surface extending horizontally outward and away from the supporting pin to reduce the capacity between the metallic surface and the pin. (2) An insulator comprising a body of dielectric material having an inner screw-threaded opening to receive a supporting pin, and a petticoat extending downwardly from the body and surrounding the pin, the inner surface of the petticoat having screw-threaded corrugations of the same pitch but of larger diameter than the threads of the pin, whereby an integral mold may be used to form the two sets of threads on the inner surface of the insulator and the mold may be unscrewed from the interior of the insulator.

System of line insulation and insulators therefor. LOUIS STEINBERGER. U. S. 1,702,235, Feb. 12, 1929. (1) In a system for supporting a high-tension transmission conductor, an insulator having an air chamber formed therein, a stress distributing supporting ring for the insulator, an electrode extending through the air chamber in the insulator and through the stress distributing supporting ring, and means electrically connected with the electrode for supporting the conductor. (2) In a system of insulation comprising a plurality of dome type insulators, a conductor secured to the insulators and a grounded ring-shaped electrode secured to each insulator body, an electrode secured to the conductor and situated in juxtaposition to the ring-shaped electrode.

High-tension insulator construction. ARTHUR O. AUSTIN. U. S. 1,702,236, Feb. 12, 1929. An insulator comprising a dielectric member having a radially extending flange thereon, fittings connected with the member at opposite sides thereof, dielectric material forming pocket-shaped capacitance glands at opposite sides of the flange and extending radially away from the fittings, the pockets being closed at their outer peripheries but open at the sides thereof adjacent the fittings, conducting material in the pockets, the material in one pocket being spaced from the fitting adjacent thereto, and a high resistance element electrically connected in series between the conducting material and fitting and constituting a heating element in the pocket.

Manufacturing insulator pins. ARTHUR O. AUSTIN. U. S. 1,702,237, Feb. 12.

1929. The process of manufacturing an insulator pin wherein a pin body and base are separately formed, the base being shaped and partially perforated by forging after which the perforation is completed by a severing operation, the interior of the perforation being given a predetermined taper to correspond to a tapered portion of the pin body, the shape of the tapered perforation being produced by a tool of corresponding shape and size which is forced into the perforation.

Insulator and fitting therefor. ARTHUR O. AUSTIN. U. S. 1,702,238, Feb. 12, 1929. Means for connecting a pair of insulators comprising U-shaped links arranged to extend through the respective insulators, the ends of the links being bent upon themselves to form hooks, a pair of clamping plates arranged to bridge the space between the ends of the links, each plate having a pair of projections thereon arranged to engage a hook of each link and having a pair of openings therein for receiving the projections of the complementary plate, a fastening device for securing the plates in place on the links and abutment members on the plates to prevent straightening of the hooks under load.

Potters' jollies. H. J. WOOD, LTD., AND W. COULTER. Brit. 301,592, Jan. 30, 1929. A potter's jolley comprises a hollow rotatable body, clutch mechanism incorporated therewith in such a manner as to enable a two-part mold to be installed within and withdrawn from the hollow body while the latter is in rotation, and means associated with the jolley for automatically locking the two halves of the mold together. The mold is carried by a coned member on a spindle axially movable in a vertical shaft. The coned member in its lowered position is adapted to engage the coned part of the plate, with studs engaging bosses on the base of the body, whereby the plate and body rotate in unison. Rollers, connected to the plate by adjustable links, are adapted to projection through apertures in an annual projection on the body. When the plate is depressed due to the weight of the mold, the rollers are caused to contact with cam surfaces on the interior of the body and are thereby brought into engagement with a groove in the upper part of the mold, the two halves of the mold being then locked together. The hollow body is continuously rotated and to insert the mold in position the hollow coned member is raised and its rotation arrested.

Potters' jiggers. C. FARR AND W. BOULTON, LTD. Brit. 300,102, Dec. 31, 1928. The two parts of a horizontally divided plaster mold for use in shaping teapot bodies and other hollow-ware are adapted to be clamped together in a rotatable jigger head by means of plates or arms extending up the inside face of the jigger head and movable by a disk. The arms are adapted to be lifted with the mold by the disk and then to move outward clear of the mold in order to allow removal of the latter. The arms which are provided with bent upper ends to engage the upper mold part, are adapted to move in grooves in the inner face of the jigger head, and at their lower ends are hinged to brackets fixed to the disk. The disk is attached to the upper end of a vertically-movable disk and in normal position is supported on a plate screwed to the bottom of the jigger head. The jigger head may be adapted for a mold of different size by means of a liner.

Measuring and marking tiles. J. GEMMER. Brit. 300,136, Dec. 31, 1928. In connection with the automatic measuring and stamping of ceramic tile a series of disks is secured on a common shaft for the purpose of effecting the intermittent forward travel of the tiles, the contacting of measuring rollers with the tiles, the adjustment of a finger controlling the stamps, and the depressing of the stamp corresponding to the width of the tile.

Electric insulators. R. HADDAN. Brit. 300,419, Jan. 9, 1929. A metal capped insulator for the suspension or tensioning of electric conductors having an intermediate layer joining the cap to the insulator has an insulator head of smooth cylindrical form with a thick head at the top and a cap also of smooth cylindrical form with an inwardly

directed head at the bottom. Lead or the like is poured between the cap and the insulator forming a thick, even ring.

Electric insulators. K. A. HAWLEY. Brit. 301,046, Jan. 16, 1929. An insulator comprises a pedestal, a porcelain body, and a cap. A flange on the base of the pedestal is formed with circumferential slots for the passage of securing bolts. Between a flange on the pedestal and the flange, the pedestal is formed with hollow vertically arranged ribs, and above the flange the pedestal is roughened by providing recesses. The body is formed with petticoats and a horizontal shoulder to abut against the flange the pedestal being cemented in a central recess of the body. The cap is cemented on an upstanding central stem of the body. The inner face of the skirt of the cap is preferably formed with recesses to provide grip for the cement. Tapped holes in thickened portions of the cap are adapted to receive bolts to secure any desired element upon the cap.

Teapots, etc. J. PLANT AND RUBIAN ART POTTERY, LTD. Brit. 301,262, Jan. 23, 1929. The front portion of the lid of a teapot, coffee-pot, or like vessel is inclined forwardly and the rear part is formed with a similarly inclined protuberance or notches adapted to engage with correspondingly-shaped coöperating portions in the rim of the pot.

Equipment and Apparatus

Drying heavy clay products in a progressive drier using radiated heat and mechanical circulation. H. R. STRAIGHT. *Jour. Amer. Ceram. Soc.*, **12** [3], 175–79 (1929).—The principles which should be followed for the safe drying of clay products are discussed. These are as follows: (1) direction of air circulation, (2) rate of air circulation, (3) humidity, (4) the use of clear air, (5) temperature of air in drier. A pallet system is proposed as an ideal manner of arrangement in the drier for drying brick, hollow tile, or drain tile and similar heavy clay products.

Modern developments in radiation pyrometers. ANON. *Brick Clay Rec.*, **74** [4], 266–67 (1929).—An extremely interesting temperature measuring device has been developed by the Thwing Instrument Co. of Philadelphia. This is a radiation recording pyrometer, which is of exceptional interest in refractories and high temperature work. The new radiation receiving tube generates a high e.m.f., which is produced by a thermopile. The back section of the tube, which is totally inclosed, contains a lens to intensify the heat and light rays. The conical mirror in the receiving tube concentrates the radiant rays on to the thermopile. The front end of the tube, which is made to produce a black body effect, contains the calibration diaphragms. In the event any dust or other foreign matter should settle on the lens and interfere with correct temperature measurements, a cleaning shutter is provided at the front section of the receiving tube through which the lens may be cleaned. Radiation recording and indicating pyrometers may be used wired in parallel with each other so that readings may be secured simultaneously on the recorder and indicator. The recording radiation pyrometer makes a perfectly legible chart similar to a recording thermocouple pyrometer. The Thwing Instrument Co. also makes a partible radiation pyrometer which has a wide field of application in the clay products industry. An opening the size of a brick is left in the temporary wall built in the doorway, and the radiation tube is sighted through the opening directly at the brick being fired in the kiln. An installation such as this might be used successfully for determining temperature in scove and other types of updraft kilns. E.J.V.

New humidifying apparatus. ANON. *Ceram. Ind.*, **12** [2], 254–56 (1929).—A new type of humidistat for controlling humidity in plants has been developed by the Midwest Air Filters. This humidistat is completely automatic and is reported to vaporize 100% of the water used, is self cleaning and the capacity per unit ranges from 0 to 150 lbs. of water per hr. Practically any normal range of water pressure can be used in connection with the Midwest Humidifier. F.P.H.

Comparative screening efficiencies of manganese steel screens and perforated plate. ANON. *Min. and Met.*, **10** [266], 106–107 (1929).—To determine the relative efficiency of two sizing screens, one equipped with perforated plate, and the other with Rol-man manganese steel screens, a series of test runs were made by the Manganese Steel Forge Co., Philadelphia. In order that conditions should be fairly comparable, the load to the two screens was split evenly from the head of the conveyer belt feeding material in equal proportions to both screens, which operated side by side, and delivered material into the same bin. The Rol-man sections had square openings to produce the same size product as the corresponding sections of perforated plate. F.P.H.

Device for measuring consistency. ANON. *Rock Prod.*, **32** [2], 64 (1929).—The new device is known as a multiple-bulb consistometer, and permits making the necessary measurements in a single run without refilling, instead of a series of separate runs. In measuring the consistency of plastic materials the relation must be found between the rate of flow and the applied pressure. Since the rate of flow is now proportional to the pressure, it is necessary to make successive observations at different rates of flow. With most of the instruments previously used, this necessitated making one run for each observation, but with the six measuring bulbs of the multiple-bulb consistometer, six separate observations may be made on a single run, and thus adequate information may be obtained for determining the rate of flow which will be produced by any given pressure. F.P.H.

"Ventoplex" air current separator. ANON. *Tonind. Ztg.*, **52** [75], 1520 (1928); *Rock Prod.*, **32** [3], 110 (1929).—The "Ventoplex" (patent applied for) of the Alpine Masch, A.-G., Augsburg, is said to increase the screening capacity of air-current separators 30 to 50%. F.P.H.

A new rapid extrusive type of plastometer. P. M. GIESY AND S. ARZOOMANIAN. *Fifth Colloid Symposium Monograph*, 253–58 (1928).—Pressure is produced by Hg in a burette, connected by canvas-lined rubber pressure tubing to a chain of ordinary cast-iron pipe fittings seriated as follows: reducing coupling, nipple, street elbow, cap. The cap is pierced to allow the insertion of a capillary into a rubber stopper, which is held in by the cap. A stopcock and side outlet tee of glass are interposed between the pressure tube and the reducing coupling. If desired, a constant temperature bath may be used. (*C.A.*)

BOOKS

Stability of Metal at Elevated Temperatures. CLAUDE L. CLARK AND ALBERT E. WHITE. Price $1.00. Issued by the Dept. of Engineering Research, University of Michigan, Ann Arbor. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

A Study of Chromium Plating. RICHARD SCHNEIDEWIND. Dept. of Engineering Research, University of Michigan, Ann Arbor; price $1.00.—This is the second bulletin on this subject by S., the former being "A Study of Patents dealing with the Electrodeposition of Chromium," published April, 1928. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

PATENTS

Method of molding ceramic materials. HENRY L. CROWLEY. U. S. 1,699,502, Jan. 15, 1929. The method of molding bodies of powdered materials which comprises subjecting such powdered material to great pressure while evacuating the air whereby a nonmalleable block is produced, and thereafter subjecting such block substantially in the absence of air to a second pressure greater than the first, which is adapted to change the shape of the block without crumbling the same, whereby particles of the powder of which the block is composed are given a movement relative to each other adapted further to compact them.

Clay carrier. EUGENE W. SCHELLENTRAGER AND HORACE J. KIDD. U. S. 1,700,711, Jan. 29, 1929. In a clay carrier, a conveyer, a frame carried thereby and including notched elevator guides, a platform movable in the guides, a safety latch pivotally mounted at each side of the platform and spring urged to engagement with the notches adjacent the guides, a plurality of sheaves carried by each latch, and a supporting cable passing under the platform around the sheaves whereby the latches are normally prevented from engaging the notches.

Kilns, Furnaces, Fuels, and Combustion

Regulating temperatures in tunnel kilns. ANON. *Ceram. Ind.*, **12** [2], 254 (1929).—Regulation of temperatures in a tunnel kiln with top heat lower than bottom is practiced with the Robertson tunnel kiln at the plant of the W. S. George Pottery Co. at Canonsburg, Pa. The cross-section load of the cars is 5 ft. 3 in. by 6 ft. high and the temperature distribution is even throughout the entire load, both in the bisque and glost firing. This kiln is used to fire bisque $2^1/_2$ days during the week and glost $4^1/_2$ days a week. The temperature is changed from cone 6 for glost to cone 9 for bisque or vice versa in 3 truck lengths. Due to the excellent arrangement of new type draft regulation in the kiln, the bottom of the load is actually one-half cone hotter than the top. F.P.H.

Pipe cleaning and protective coatings for gas mains. D. R. HISKEY. *Gas Age-Rec.*, **62** [14], 428–33 (1928). F.P.H.

Study of flue-gas analyses. FRED. M. REITER. *Gas Age-Rec.*, **62** [14], 437–38 (1928).—Flue-gas analyses with varying percentages of excess air are discussed. F.P.H.

Natural gas transmission. S. C. PRESTON. *Gas Age-Rec.*, **62** [14], 439–41 (1928).—The formula for gas-line flow expressed in its simplest form is as follows: $Q = C\sqrt{\frac{P_1^2 - P_2^2}{L}}$. Q = cu. ft. of gas delivered per hour at atmospheric pressure; C = coefficient determined by experiment; 9050 for 8 in. pipe; P_1 = absolute pressure on inlet end of pipe in pounds; P_2 = absolute pressure on outlet end of pipe in pounds; L = length of line in miles. Formula may also be written: $Q = \frac{CP_1}{\sqrt{L}}\sqrt{1 - \frac{1}{R^2}}$ where $R = \frac{P_1}{P_2}$. F.P.H.

Carbonization of pulverized coal by the Bartling process. DAVID BROWNLIE. *Gas Age-Rec.*, **62** [14], 442–44 (1928).—The "Bartling" process, by means of a gas nozzle, passes a blast of pulverized coal into a small externally heated retort which is very short in height as compared with the diameter. At the nozzle a stream of gas under pressure acts as a conveying medium, and above the nozzle, in the lower part of the container, are transverse perforated baffles, which violently mix and agitate the coal and bring it into intimate contact with the heated steel wall of the container so as to give complete temperature carbonization in a comparatively few seconds. F.P.H.

Primary air requirements of gas burners. F. M. REITER. *Gas Age-Rec.*, **62** [16], 544 (1928).—In the region of rich natural gas over 1000 B.t.u. per cu. ft., very often considerable difficulty is experienced in adjusting appliances to obtain the proper sharp blue flame. During extensive tests on primary air ratios for atmospheric burners for the procurement of the best flames, curves were plotted for gases up to 600 B.t.u./cu. ft. in heat value. The curves give an extension of the average of these values up to

1100 B.t.u. gas. With a primary air requirement of 5 cu. ft. per cu. ft. of 1100 B.t.u. gas a highly efficient inspirator and a well-designed burner are essential for the production of the sharp blue flame. Poorly constructed mixtures of improper design cannot be successfully applied at high heat value gases. F.P.H.

Considerations for theoretically correct gas plant. FRANK W. STEERE. *Gas Age-Rec.*, **62** [16], 545–48; [17], 581–84 (1928). F.P.H.

World fuel conference covers new developments. A. C. BLACKALL. *Gas Age-Rec.*, **62** [17], 577 (1928).—Among the important topics included in the Gaseous Fuels Section of the World Fuel Conference, held in London, were the classification and analysis of gaseous fuels, the manufacture and purification of gas, the recovery of by-products, and the production of solid smokeless fuel. In his general contribution on gas manufacture, J. W. Cobb showed that the thermal efficiency of the carbonization process allowing for the heat used and lost in the manufacture, has increased from 70% in 1919 to 85% at the present time, for a carburetted water gas plant works has an overall efficiency of about 70%. Cobb suggests that with a steam-oxygen blast a simple continuous gas producer could be designed to work with an efficiency of 90% though oxygen has not yet been produced at a price sufficiently low to permit it to be used in gas-making. F.P.H.

Economic and engineering survey of the gas industry. H. E. BATES. *Gas Age-Rec.*, **62** [17], 578–80 (1928). F.P.H.

Improvements in producer gas manufacture. W. T. DAUGHERTY. *Gas Age-Rec.*, **62** [17], 580 (1928).—Improvements in cheapening costs of production of water and producer gas for the direct ammonia synthesis at the Leunawerk have occupied chemical research for the past few years. The present process involves the introduction of coal dust into an air or steam current, thus converting it to gas. Finely divided coal is introduced into the lower part of a funnel or cone-shaped gas generator where it comes into contact with a stiff air current. Because of the shape of the generator an equilibrium is created between the air pressure and the fine parts of the coal. The transformation of gas occurs under favorable conditions of rising temperature and maximum surface exposure of the fine coal parts to the gas generated by them. The Leunawerk have finally developed a cheaper process based on finely milled lignite or brown coal. It is said that the gas generator employed has a cross-section of twelve square meters capable of gasifying 750 metric tons of lignite per 24 hours. The process involves incomplete oxidation to carbon monoxide up to 1100 to 1200°C when the operation is reversed to water vapor. Ash is carried into the process but removed in special purification chambers. The water gas produced contains an average of 43% carbon monoxide, 45% hydrogen and 2.5% carbon dioxide. If this process proves successful it will contribute effectively to cheapening costs of hydrogen, the most expensive item in ammonia synthesis. F.P.H.

Gas purification in relation to coal sulphur. F. W. SPERR, JR. *Gas Age-Rec.*, **62** [23], 785–90 (1928).—The following gases of present industrial importance are manufactured from coal: (1) coal gas made in by-product coke ovens or gas retorts; (2) water gas principally made from the coke obtained as a by-product of coal gas manufacture, but also produced from anthracite and, in recent years, from certain grades of bituminous coals direct; (3) producer gas made from coal or coke. In the processes of manufacturing any of these gases, part of the sulphur in the coal goes into the gas and must be removed if the gas is to be used for domestic or for certain industrial purposes. Hydrogen sulphide is always the predominant sulphur compound. The actual proportion of hydrogen sulphide in purified city gas is less than 0.1 grain per 100 cu. ft. The sulphur compounds, other than hydrogen sulphide, are of organic nature and with the exception of carbon disulphide are present in very small amounts.

Where low sulphur coals are used, the removal of carbon disulphide is not undertaken. Regulations usually specify less than 30 grains per 100 cu. ft. of organic sulphur. F.P.H.

Sauerbrey process of low temperature carbonization. DAVID BROWNLIE. *Gas Age-Rec.*, **62** [25], 857–58 (1928).—The most important low temperature carbonization processes involve the use of a long, horizontal or slightly inclined, mechanically continuous, cylindrical rotary retort, which may be heated externally, internally, or by both methods together, on somewhat the same general lines as a rotary kiln. Many attempts to use retorts of this character at high temperatures have been abandoned because of the severe wear, cost of upkeep, and breakdowns, especially as external heating only was almost invariably used so as not to dilute the rich gas. The principle of using a long, rotary cylinder for heat treatment in general, such as cement manufacture, low temperature carbonization, and many processes in the heavy chemical industries, in the manufacture of plaster, date back to over a century ago. The general principle of rotary cylinder has been adopted on new and most ingenious lines in Germany by the Sauerbrey Engineering Co. of Stassfurt, primarily intended for lignite, shale, noncoking bituminous coals, and other material in a more or less fine state of division that does not become plastic on heating. It is mechanically continuous low temperature carbonization combined with a high "throughput" and consequent low cost of retort per unit throughput per 24 hours. F.P.H.

Influence of inorganic constituents on carbonization and gasification of coal. J. J. PRIESTLEY AND J. W. COBB. *Gas Jour.*, **181**, 951–54 (1928); *Gas Age-Rec.*, **62** [16], 559 (1928).—The apparatus used was designed to allow a charge of about 20 g. of coal or coal mixture to be heated in a definite manner from 200°C to 1000°C, while a stream of purified nitrogen or hydrogen was sent through the charge, the hydrogen sulphide evolved being absorbed in cadmium acetate solution. The apparatus is shown. The temperature of the coal charge was measured by means of a thermocouple. The cadmium sulphide formed was determined as well as the coke which was also analyzed. With the "pure" coal in nitrogen 42% of the sulphur was evolved in heating to 1000°C, 34% of which had come off before rising beyond 600°C. Very little was coming off when the heating was finished. The 500°C stage was all important. Heating in hydrogen showed the same results up to 500°C, but rapid decomposition took place at 600°C and the total decomposition amounted to 68% at 1000°C. Little sulphuretted hydrogen was evolved at 1000°C with the iron oxide-coal mixture. Decomposition, however, took place readily about 500°C when the mixture was heated in hydrogen. Experiments were also made with sodium carbonate and coal mixtures. The results are of considerable importance as far as the behavior of these mixtures in actual carbonization operations is concerned. F.P.H.

Influence of temperature and pressure on distillation of coal. M. BOLZINGER. *Le Gaz et L'Electricite*, p. 238 (1928); *Gas Age-Rec.*, **62** [24], 822 (1928).—Formulas are derived to connect the volumetric production of gas with the temperature and the time. Theoretical and experimental curves are obtained, the experimental results being secured from distillation of coal charges of 0.5 to 1 kg. in a small laboratory experimental apparatus. The conclusions derived indicate that the increase of the temperature of the walls of the laboratory retort (1) increases the volume of gas obtained per ton of coal charged, (2) decreases the calorific power of the gas per unit volume, (3) increases the total number of calories obtained per ton of material charged, and (4) diminishes the minimum duration of the distillation process. As far as the diminution of the pressure within the retorts is concerned, which pressure is relatively low when figured on the absolute basis, such practice increases to a sensible degree the volumetric production of gas and diminishes its calorific power. F.P.H.

Flow of gases through beds of broken solids. C. C. FURNAS. Bur. Mines, *Rept. of Invest.*, Serial No. 2904, December (1928).—This report is a brief summary of the experimental work on the problem at the North Central Experiment Station. The amount of gas flowing through a bed of broken solids under the driving force of a given pressure drop depends upon some 15 or more variables. The complete solution of a problem involving 15 variables would be almost hopeless; fortunately, several are relatively unimportant and may be neglected. The experimental work has been confined to a study of the following variables: density of gas, size and shape of particles in bed, degree of packing, size of container, size composition of beds of mixed sizes, viscosity of the gas (effect of temperature and composition), molecular weight of gas. A few data were also taken on the effect of moisture in the bed, but this item has not been emphasized. The results have all been tabulated as the pressure necessary to force gas through a given bed at a given rate. Formulas are given and discussed with examples of use of equations covering the various variables considered. R.A.H.

Commercial standards for furnace and fuel oils. ANON. *Amer. Glass Rev.*, **48** [15], 33 (1929).—A general conference of oil refiners, fuel oil distributors, manufacturers of oil-burning equipment, organized consumers, representatives of engineering associations and other interests, was held in New York, Jan. 9, to consider a proposed commercial standard for furnace and fuel oils. E.P.R.

Government-owned lands rich in mineral deposits. ANON. *Nat. Glass Budget*, **44** [41], 16 (1929).—On the public domain there are 30,000,000 acres of coal land which contain 200,000,000,000 T. of fuel for the future. E.P.R.

BOOK

Handbook of Petroleum, Asphalt, and Natural Gas. ROY CROSS. Revised edition. 830 pp., 215 illustrations. Kansas City, Mo.: Kansas City Testing Laboratory, 1928. Price $7.50.—Has chapters on economics, transportation, storing and gaging, properties, methods of analysis, and reference tables. H.H.S.

PATENTS

Water gas producer. J. PINTSCH. Brit. 295,717; *Gas Age-Rec.*, **62** [24], 842 (1928).—Continuous process generator is provided with a central tube externally heated. At the top of the tube is an annular space into which pulverized fuel is fed. The ash is collected in a chamber located at the base end of the tube. The central tube is surrounded by heat regenerators. F.P.H.

Pottery kilns. F. BENNION, H. J. PLANT, AND J. B. CLARKE. Brit. 301,270, Jan. 30, 1929. At the back of each fire-mouth of a pottery kiln is a flue terminating in ports through which the heating gases pass to the goods, the ports being arranged near the kiln wall and being raised slightly above the floor. The gases leave the kiln through a perforated flue erected above the outlet flue as described in Brit. 287,693 (see *Ceram. Abs.*, **7** [9], 636 (1928)), or through a similar imperforate flue extending upward nearly to the roof. The holes in the flue may be circular, square, or in the form of slots. The kiln lining consists of fireclay boxes filled with diatomite or other nonconductor of heat.

Automatic shut-off for gas lines. H. SCHMUCK. Ger. 463, 573; *Gas Age-Rec.*, **62** [24], 842 (1928).—A device acts automatically by means of a piston within a cylinder when the pressure in the gas line is suddenly decreased. The direction of the gas flow is always perpendicular to the movement of the piston. F.P.H.

Geology

Feldspar industry in Pennsylvania. R. W. STONE. *Rock Prod.*, **32** [2], 42–46 (1929).—Twenty years ago Pa. held second rank as feldspar producer. Small operations and hand labor methods have reduced this state to eighth in rank. The consumption in the U. S. is divided as follows: ceramic industries 84.0%, roofing and cement sur-

facing 6.0%, cement manufacture 5.0%, scouring soaps and abrasives 2.5%, binder for abrasive wheels, etc., 2.0%, poultry grit 0.5%. F.P.H.

Kaolin deposit in Missouri. ANON. *Brick Clay Rec.*, **74** [2], 102 (1929).—Kaolin of a high quality has been discovered at Iron Mountain, Mo., on the property of the Missouri Ore Co. When subject to heat the clay becomes firm with a metallic ring. Just across the county line from the new tract at Kaolin in Iron County fire clay was manufactured into jugs and other articles prior to the Civil War, but later the project was abandoned on account of its remote and inaccessible location. E.J.V.

Gypsum production in Nova Scotia during 1928. J. P. MESSERVEY. *Can. Chem. Met.*, **13** [1], 22 (1929).—Gypsum was mined in Nova Scotia as early as 1829, but in recent years the industry has had its most remarkable expansion. The past year's output of over 950,000 T. is more than 3 times that of all the rest of Canada. Gypsum deposits containing an excellent grade of material are widespread in the central and eastern parts of the province, and are extensively worked in a number of localities. The chief producing center is in the vincinity of Windsor, though there is an increasingly large output from a number of quarries scattered over Cape Breton Island. The Canada Cement Co. has recently opened large quarries in Antagonish County, on the mainland. In spite of the large gypsum production, less than 2% of the output is calcined in the province, nearly all of it being shipped to the U.S. The gypsum is found in the lower carboniferous measures in 52 distinct areas, and the deposits cover about 625 square miles. The annual output in 1872 was 99,470 T. The figures, in tons, for the last 4 years show the rapid increase in its production: (1925) 471,174; (1926) 607,116; (1927) 851,953; (1928) 972,211. It is all produced by the open-cut or quarry method of mining. E.J.V.

Diatomaceous earth. J. P. MESSERVEY. *Can. Chem. Met.*, **13** [1], 24 (1929).—Recently a large deposit has been under development at Digby Neck, Nova Scotia. Diatomaceous earth has for many years been extracted in a small way in Colchester County, N. S., by the Oxford Tripoli Sales Co. This company has also installed a new plant at East New Annand. They have located 4 large bogs containing a big tonnage of diatomite. E.J.V.

Official estimate of Canadian mineral production, 1928. S. J. COOK. *Can. Chem. Met.*, **13** [1], 41 (1929).—Advances were general in all fields (metals, nonmetals, and structural materials) and the following products reached new output records: cadmium, cement, coal, copper, gold, gypsum, lead, lime, natural gas and petroleum, sand and gravel, salt, stone, talc, soapstone, and zinc. The production of fuels (comprising coal, natural gas, and crude petroleum) was nearly $2,000,000 greater, at $73,420,000. Other nonmetals, including asbestos, feldspar, quartz, salt, gypsum, magnesite, pyrites, talc, and soapstone, were valued at $17,450,000, a slight decrease from the 1927 figure. The production of clay products (brick, tile, sewer pipe, pottery, etc.) amounted to $12,250,000; that of cement, $16,803,000; lime, $4,170,000; stone, sand, and gravel, etc., $18,407,000, making a total for the Structural Materials division of $51,630,000, as compared with $44,809,419 in the preceding year. E.J.V.

Italy's kaolin supplies. ANON. *Pottery Gaz.*, **54** [620], 296 (1929).—In Italy there is kaolin in the province of Vicenza, at Schio and Sant' Orso, in Toscana and Roccastrada, in the province of Florence, and in Sardinia. Vicenza kaolin is inferior to the French of Brittany, Limousin, and the Pyrenees. The production is modest and barely suffices for the requirements of a few factories. The Roccastrada reserves are too small to be important, and those of Sardinia are not plastic and are not on the market. Thus Italy's reserves of kaolin are far from satisfying Italy's requirements. Italy is thus a good market for foreign supplies. The latest statistics published give the following details on the importation of kaolin for nine months:

	Tons	Value
From Czechoslovakia	2905	714,800 lire
" France	1231	444,556 "
" England	13,069	4,166,995 "

The Italian ceramic industry has developed well, particularly since 1924, mostly in the production of porcelain insulators. The new insulator factories at Laveno and Cairo Montenotte are managed by Germans, who prefer German and Czechoslovakian raw material. Nevertheless, the French make strong efforts to sell their raw material from Limousin and Brittany, maintaining that these are "equal to the English" and to the Czechoslovakian, and they possess the advantage of a much cheaper transport. Fine feldspar is found in Italy at Delvio, at Colico, and Lecco, on Lake Como, at Luzerna San Giovanni, in Piedmont, and at Parghellia (Catanzaro). Italy requires about 1000 T. of feldspar for her ceramic industries per month. A large quantity, however, is imported from Sweden, Norway, Germany, Czechoslovakia, England, and France. The French "pretend that their feldspar of the Pyrenees can compete with Scandinavian," while in reality it contains appreciably less alkali. The feldspar is usually imported in lumps, and it is usually ground in the factories. Imported feldspar pays a duty of 31.70 lire per ton. The Italian ceramic industry is concentrated mostly around Milan and Genoa. E.J.V.

Development of ceramic industries in the south. A. V. HENRY. *Mfrs. Rec.*, **95** [5], 45–47 (1929).—In recent years notable progress has been made in establishing a variety of clayworking plants in this section which contains abundant raw materials. Almost one-third of the country's mining production is located in the south. Kaolin is available in Ga., S. C., Fla., N. C., and Tex.; ball clays in Tenn. and Ky.; feldspar in N. C.; and flint in Ga. and N. C. Refractory clays and bauxites in the southeast are readily accessible and of high quality. An outstanding area of refractory materials is located in Ga. Immediately south of the Fall Line, extending diagonally across the state from Augusta, through Macon to Columbus, is a belt containing large deposits of sedimentary kaolins, refractory clays, and bauxites. The deposits often exceed 40 ft. in depth and can easily be worked by open pit methods. Railways, in many cases, are adjacent. All tests show these clays to be superior for high duty refractory service. Raw materials are ample for a distributed production of building brick, hollow tile, roofing tile, sewer pipe, and Portland cement. The quantities of these products manufactured in the south are satisfactory. Most of the southern states are producing coal in important quantities, while those not producing, either have resources that can be tapped or are producing oil or natural gas. The distribution of fuel production is such as to insure ample and fair priced power for southern industries. Education in ceramic industries has not been neglected. Complete departments in ceramics have been operated during the past five years at the Georgia School of Technology and N. C. State College of Agriculture and Engineering. These colleges are also devoting much time to the economic possibilities of the clays and minerals of the South. The Geological Survey of the various southern states is doing much to determine the facts with regard to the minerals of their respective areas. Of national scope and importance to ceramic industries is the AMERICAN CERAMIC SOCIETY. This organization is composed of persons interested in ceramics, most of whom are technically trained. The SOCIETY and its membership are responsible, in a large measure, for the high state that ceramic industries hold in this country. E.P.R.

Steady diversified expansion features North Carolina's ceramic industry. A. F. GREAVES-WALKER. *Mfrs. Rec.*, **95** [5], 50–52 (1929).—At the beginning of this era of expansion, the products of the plants then operating consisted almost entirely of common clay brick, sewer pipe, and flue lining. At present, shale face brick, buff and gray face

brick, hollow tile, and chemical brick and tile are being produced. Previous to 1923 there was not a modern feldspar grinding plant in the state and only one of antiquated design. Large reserves of feldspar were located in Avery, Yancey, and Mitchell counties. In the past 4 yrs. the grinding capacity of the mills has been increased from 35 to 400 T. per day and shipment of crude rock for processing outside the state has stopped. N.C. now produces 60% of the feldspar used in the U.S. The quality of kaolin has been greatly improved by the adoption of modern methods of refining. Pottery, representing a native art, has attracted favorable attention and has more than tripled in value in the past 4 yrs. All the materials necessary for the establishment of the whiteware industry within the state have been located in quantity except ball clay. The ball claylike kaolins of the French Broad Valley give an assurance of a supply of this type material for some kinds of ware, especially the ivory tinted dinnerware, and any deficiency is easily taken care of by the nearby deposits of Tenn. No high grade fire clays have been found within the state, but what appears to be the largest known deposits of cyanite have been traced from Burnsville almost to the Ga. line. Development of N. C. cyanite only awaits the necessary capital to erect plants to separate the cyanite from the rock in which it is imbedded. E.P.R.

Asbestos. OLIVER BOWLES. *Mineral Ind.*, **36**, 40–48 (1927).—The peculiar properties of asbestos make it of special value in many industries. The U.S. is the largest manufacturer of finished asbestos in the world, but produces only a small proportion of its requirements of raw material, which to a large extent are supplied from the rich deposits of Quebec, Canada. E.P.R.

Fullers' earth. HERMAN GUNTER. *Mineral Ind.*, **36**, 211–12 (1927).—The term fullers' earth has come to include a number of kinds of clays or claylike substances. The clays may vary in color from light buff to light green or gray. Some of the fullers' earth clays are not readily distinguishable from other more common clays. As a rule a high-grade fullers' earth is very light, having a low specific gravity. When placed in water, it will usually slake and disintegrate readily. Some fullers' earths are plastic when wet, others are nonplastic or mealy. But all of these and other characteristics while helpful in forming an opinion as to the nature of a clay, are in no wise conclusive. A practical physical test of fullers' earth is necessary in order to determine its value as a filtering medium. The claylike substances replacing fullers' earth as a filtering agent come principally from the western states, chiefly California. The production from this state in 1926, although recorded as fullers' earth, was actually a colloidal clay of the montmorillonite group. This clay is sold under various local trade names as "shoshonite," "otaylite," and "bentonite." The output of this clay increased very materially during the year 1926, and from reports its efficiency as a filtering and clarifying agent is becoming more generally known. E.P.R.

BOOKS

Mineral Production of Canada, 1926. DOMINION BUREAU OF STATISTICS. Price 50 cents.—Valuable statistics have been compiled on various branches of this industry and a directory of all concerns operating in Canada. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

Manufacturers of the Nonmetallic Minerals in Canada, 1926. DOMINION BUREAU OF STATISTICS. Price 25 cents.—In the year reviewed, the output of the 1241 plants operating in this class in Canada amounted to $173,587,527. A list of the reporting firms, arranged by industries and provinces, is given. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

Mineral Industry of the British Empire and Foreign Countries: Statistical Summary. (Production, Imports and Exports, 1925–27.)—A publication of the Imperial Insti-

tute, London. Price 8*s*. The book makes a very valuable statistical reference on minerals throughout the world. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

Chemistry and Physics

Waste-heat drier calculations and charts. A. E. R. WESTMAN AND R. G. MILLS. *Jour. Amer. Ceram. Soc.*, **12** [3], 162–74 (1929).—Equations were developed which, when used in conjunction with hygrometric charts, enabled the usual waste-heat drier calculations involving heat supply and water removal to be performed by direct substitution. These equations were used in preparing charts showing the effect of (1) atmospheric humidity conditions, and (2) air discharge temperature on the operation of a typical waste-heat drier. The advantages which might result from the control of the initial moisture content of the air used in drying and the feasibility of using silica gel for this purpose are discussed. Changes in drier design which would permit higher exit temperatures for the air used in drying are suggested by the outcome of the calculations.

Colloidal content of china clays. ANON. Bur. Stand., *Tech. News Bull.*, No. 141, pp. 2–3 (1929).—Included in the program of the china clay investigation is a study of grain size distribution. While this has been carried out by the sedimentation process and application of Stoke's law down to a particle size diameter of 1.7 microns, the data indicated that from 35 to 60% of the total clay had a grain size of less than 1.7 microns. Since this large quantity of finely divided material undoubtedly has a pronounced effect upon the properties of the clay, it seemed desirable to make a further classification as to size. To this end the Sharples supercentrifuge was applied. Separations were made with speeds of 12,000, 18,000, and 40,000 r.p.m. with proper rates of flow to obtain the desired results. Data on a few clays have been obtained R.A.H.

Technical control in the ceramic industry. ANON. *Sprechsaal*, **61** [34], 663–66 (1928).—This subject is discussed under the following classification: (1) Technical control of operations: (*a*) raw materials including clay and kaolin, ores (sand), feldspar, pegmatite, chemicals, fuels and oils; (*b*) manufacture of bodies, semifinished products, and finished article, and remedies in manufacture. (2) Control of output: mass production, individual production, and wage statistics. (3) Sales Control: records of orders, sales, and stores. R.A.H.

Studies in adsorption. XXII. M. R. MEHROTRA AND N. R. DAHR. *Jour. Phys. Chem.*, **33** [2], 216–25 (1929).—NaOH and KOH are highly adsorbed by $Cu(OH)_2$ in the course of its precipitation. $Cu(OH)_2$ prepared from $CuCl_2$ is a better adsorbent than the hydroxide obtained from $CuSO_4$. Both cupric ions and sulphate ions are adsorbed by $Cu(OH)_2$. The two ions are in equivalent proportion. $CuCl_2$ is also adsorbed by $Cu(OH)_2$ but it volatilizes when the hydroxide is ignited. Quantities of alkali slightly less than the equivalent amounts can effect complete precipitation of Cu from cupric salts. This is due to the adsorption of cupric salts by $Cu(OH)_2$. The experimental results on the adsorption of $CuSO_4$ by $Cu(OH)_2$ support the existence of the basic salt, $3Cu(OH)_2 \cdot CuSO_4$. The adsorption equation, $a = A\frac{(KC)^{1/n}}{1+(KC)^{1/m}}$, when a is the amount of adsorption, A is the maximum adsorption, and K is a constant, is applicable to the results obtained in the adsorption of NaOH and KOH by $Cu(OH)_2$. L.A.P.

Solubility of calcium hydroxide. L. B. MILLER AND J. C. WITT. *Jour. Phys. Chem.*, **33** [2], 285–89 (1929).—The solubility of $Ca(OH)_2$ in water as exhibited by freshly hydrated CaO is made the subject of a detailed study. The progress toward equilibrium of the system consisting of an excess of freshly hydrated CaO and water

was followed closely by means of the electrical conductivity of the solution. Values for the solubility of $Ca(OH)_2$ and for the conductivity of the saturated solution are given. L.A.P.

X-ray examination of structural materials. WHEELER P. DAVEY. *Mech. Eng.*, **50** [3], 213–16 (1928).—Because of the dependence of mechanical engineering on the properties of structural materials, the X-ray has become a tool of considerable usefulness to engineers, not only in explaining facts which were previously known, but also in clarifying our ideas of structural materials and so paving the way for the development of additional materials to meet new requirements. L.A.P.

Preparation of pure silicic acid solution by means of electrodialysis. I. SHUMPEI OKA. *Jour. Soc. Chem. Ind., Japan*, **31** [12], 306–307B (1928).—Preparation of pure silicic acid solution directly from sodium silicate solution by means of electrodialysis was studied. Pure sodium metasilicate crystal ($Na_2SiL_3 \cdot 9H_2O$) was prepared by twice repeated recrystallization, and was used as solutions containing 10, 23 or 33% $Na_2SiO_3 \cdot 9H_2O$. Electrodialysis was carried out in a two-compartment cell (300 cc. each) using parchment paper as the diaphragm (4 × 10.5 cm.), and purification was completed in a three-compartment cell of the same cross-sectional area. The voltage was regulated within 10 to 100 volts to maintain the current at 1, 2, or 4 amperes (mainly 4) as long as possible. When the total resistance became too large to maintain a constant current, a constant voltage (100 or 150 volts) was applied. Sodium ion in the silicate solution in the anode compartment passed the diaphragm into the distilled water in the cathode compartment by electric current, was discharged and turned into sodium hydroxide. To remove this increasing amount of sodium hydroxide in the cathode compartment, the distilled water in this compartment was syphoned out at the end of every 30 minutes, and new distilled water was poured in. The removal of sodium from silicate solution was followed by the titration of the syphoned out cathode water, from the results of which the apparent current efficiency was calculated. By treatments of up to about 1000 minutes, pure silicic acid solutions of 1.39–4.46% were prepared from silicate solutions of 10, 23, or 33%. The current efficiency was found to decrease gradually with the decrease of sodium concentration in silicate solutions. The total loss of silicic acid during the treatment was found to be 5 to 60% of the silicic acid in the original silicate solution, which was mainly due to the coagulation of silicic acid on the anode surface and less to the diffusion through the diaphragm. The loss due to coagulation may be much lessened by suitable control of anode current density, good agitation, and greater dilution of solution. **II. Some properties of silicic acid obtained.** *Ibid.*, 307–308B (1928).—Some of the chemical and physical propertes of silicic acid solutions obtained by means of electrodialysis were measured. The results are shown below:

	No. of experiment			
	(2)	(5)	(6)	(3)
Specific gravity (d_4^{25})	1.0030*	1.0143	1.0212	1.0149
Specific viscosity (η^{25})	1.049*	1.072	1.231	1.229
Specific conductivity (25)	1.48×10^{-4}*		4.21×10^{-4}	2.75×10^{-4}*
100 g. solution contains (g.) SiO_2	1.45	3.21	4.46	3.34
Impurity (mainly Fe_2O_3 and Al_2O_3)		0.0084	0.0080	0.0070
Na	Trace	0	0	0

* Values with this mark were measured at 30°.

The solution seems to have higher dispersion than those prepared by other methods, but not so high as to be molecular. When kept long, the specific viscosity increased gradually, and specific conductivity decreased gradually, which shows the polymerization of silicic acid particles in the solution. But no coagulation occurred during

8 to 13 months storing, except in one sample, namely, a part of the acid obtained by experiment No. 2 sealed in a soda glass tube coagulated after 2 months, storing. This shows how stable such solutions are. The molecular weight was measured with acid No. 6 at 6 months after the preparation by means of freezing-point depression method, and was found to be 9150, assuming silicic acid to exist as entirely undissociated molecules such as $(SiO_2)_n$. E.J.V.

X-ray investigation of effect of heat on china clays. T. N. McVay and C. L. Thompson. *Pottery Gaz.*, **54** [620], 295 (1929); abstracted from *Jour. Amer. Ceram. Soc.*, **11** [11], 829–42 (1928); see also *Ceram. Abs.*, **7** [12], 864 (1928). E.J.V.

Cobalt. C. W. Drury. *Mineral Ind.*, **36,** 112–15 (1927).—The cobalt of low-cobalt ores is volatilized in reverberatory furnaces. If the ore is rich in cobalt and copper, the smelting is conducted in a water-jacketed furnace; the slag containing cobalt silicate analyzes cobalt 6.5%, copper 5, and iron 9 to 11%. The slag is treated in 400-kw. electric furnaces. E.P.R.

Chemical engineering in 1928. A. J. V. Underwood. *Chem. and Ind.*, **48,** 33–35 (1929).—Progress in chemical engineering design, though substantial, has not kept pace with the wide range of materials now available to the chemical engineer. The controlling factor in progress therefore is the development of fundamental principles. U. deals with power generation, heat transfer, drying, the use and recovery of volatile solvents, filtration grinding, high-pressure processes, protective coatings, the use of rubber and bakelite, and the advantage of continuous over intermittent processes. H.H.S.

Warsaw chemical research institute. R. Truszkowski. *Chem. and Ind.*, **48,** 36 (1929).—Opened last year, the Warsaw Institute took over from "Metan," a private society founded in 1916 by Ignacy Mošcicki, the President of Poland. The object of the Institute is to carry out research on chemical questions of national, economic, industrial, and military importance. The problems dealt with during the year included classification of Polish coals, the production of Al from clay, and of ammonium sulphate from gypsum, the freeing of sand from iron, the preparation of heavy aero-engine oils, and the surfacing of roads with sodium silicate. H.H.S.

Atomic weights. German Atomic Weight Commission. *Chem. and Ind.*, **48,** 95 (1929).—The Commission has issued the following revisions: Ba 137.36 (from 137.37); Ce 140.13 (140.2); Er 167.64 (167.7); Ne 20.18 (20.2); U 238.14 (238.18). H.H.S.

Preparation of ammonium sulphate from gypsum. M. Paul Baud. *Compt. rend.*, **21,** 1138–41 (1927); *Tonind. Ztg.*, **52** [46], 946 (1928); for abstract see *Ceram. Abs.*, **7** [7], 425 (1928). F.P.H.

Accuracy of the Morehead gas apparatus. H. L. Olin and W. G. Ingram. *Gas Age-Rec.*, **62** [14], 445–47 (1928).—Certain gases such as carbon monoxide may be estimated by colorimetric methods at a concentration of the order of one part in 10,000 while other common ones are measurable in only slightly lower degree. The Morehead apparatus, widely used in gas plant laboratories, meets the ordinary requirements for simplicity in design and operation, and gives results that can at least be readily duplicated. This device consists essentially of a graduated burette fitted with platinum contacts, which serves the multiple purpose of measuring tube for the original sample, absorption and washing chamber of the soluble constituents, and explosion pipette for the determination of hydrogen and methane. Where accuracy is demanded other means than those provided by the Morehead method must be employed especially in the determination of hydrogen and the hydrocarbons. The instrument is fairly satisfactory for the other constituents of a fuel gas mixture where approximations only need be sought. F.P.H.

Plastic cellulose in scientific research. K. HICKMAN AND D. E. HYNDMAN. *Jour. Franklin Inst.*, **207** [2], 231–44 (1929).—Transparent cellulose sheeting is usually made from cellulose nitrate or cellulose acetate. The nitrate is known as celluloid, a trade name for a special product of pyroxylin. Pyroxylin materials have a wide variety of laboratory uses. The limitations are low combustion point and the fact that nitrate decomposes in absence of air. The cinematograph film is made from the acetate base. The material will not stand strong liquids although it will resist 20% sulphuric acid indefinitely. Detailed discussion for bending bars and sheets are given. Special cements give welds of strength equal to that of the material. In welding to other materials such as glass or metal the welds hold well until one edge becomes loosened. The best methods for welding are explained. A list of uses in laboratories for which pyroxylin vessels and articles can be put is given. J.T.L.

Adsorption of iron from ferric hydroxide sols and from ferric chloride solution by kaolin and talc. A. FODOR AND A. ROSENBERG. *Kolloid Zeit.*, **46**, 91–94 (1928).—Iron sols were prepared by hydrolysis of $FeCl_3$ solutions and dialyzed until Cl-free. When these sols were shaken with purified and washed kaolin or talc the total iron was adsorbed. When $FeCl_3$ solutions were hydrolyzed by boiling water and then shaken in contact with kaolin the following observations were made: (1) in higher concentrations displacement of the degree of dissociation of the $FeCl_3$ solutions took place, the newly formed colloidal ferric hydroxide molecules being adsorbed by the kaolin; (2) in dilute solutions no such displacement occurred since nearly complete dissociation was reached before adsorption took place; (3) the acids were not adsorbed; and (4) in dilute solutions the adsorption proceeded to an equilibrium. This adsorption equilibrium apparently depended upon the free acid concentration. When $FeCl_3$ solutions were shaken with talc the following changes occurred: (1) first an exchange adsorption, the H ions disappearing and the Mg ions appearing in the solution, (2) the adsorption of the colloidal ferric hydroxide formed by the adsorption of the acid. Aluminum hydroxide sols were not adsorbed by either kaolin or talc. When mixtures of $AlCl_3$ solution with $FeCl_3$ solution were heated to boiling and shaken with kaolin or talc all the iron was adsorbed while the aluminum passed through the filter. H.I.

Determination of manganese in the presence of silica. CLIVE NEWCOMB. *Analyst*, **53**, 644–45 (1928).—In the colorimetric determination of Mn as MnO_4^- difficulty is encountered if SiO_2 is present, as in the examination of plant ashes, on account of the tenacity with which SiO_2 adsorbs Mn. The difficulty can be overcome by fusing with Na_2CO_3, dissolving the melt in water and adding it at once to an excess of HNO_3. The resulting solution is a colloidal one but all the Mn therein can be oxidized by persulphate and the cloudiness disappears when the oxidation to MnO_4^- is complete so that the colorimeter can be used. (*C.A.*)

Colloid types. EUGENE C. BINGHAM. *Fifth Colloid Symposium Monograph*, pp. 219–28 (1928).—From the standpoint of plastic flow, colloids show 3 types: non-polar, *e.g.*, a suspension of a finely divided solid in a very viscous medium; emulsions, *e.g.*, fats and greases, which when molten, behave as viscous liquids, but become plastic as solidification begins; polar, *e g.*, gelatin in water, where the increase of concentration of the dispersed phase is more marked than with the first type. The so-called "solubility" of polar colloids has long been roughly measured by the apparent viscosity of the solution in different "solvents." This method is of course open to various objections for these are not true solutions or true viscosities, and it is not apparent that one would be an exact measure of the other. With a single crystal since the flow takes place along slip planes, it differs from the foregoing. With ordinary crystalline mixtures, the situation is more complicated. (*C.A.*)

The grinding of materials. Theoretical and experimental researches on particle-size distribution incident to the disintegration process. A. H. M. ANDREASEN. *Kolloidchem. Beihefte*, **27**, 349–458 (1928).—It is emphasized that the character of a disintegrated product is to be considered in determining the most satisfactory means of disintegration. A single numerical value, *e.g.*, the particle surface-area increase per unit of material, is an insufficient criterion to measure character of product. Particle-size distribution is an essentially better basis for judgment. A critical discussion of accepted research methods is given and a method proposed to give the best results for particle-size distribution determinations consisting of the application of sifting, wet elutriating, and sedimentation. A series of related problems is given, the solution of which by mathematical considerations led to the development of a series of ideas in regard to particle size, shape, and degree of disintegration. Later a series of functions is defined for use. The relations so derived were then applied to 2 special cases: (1) that the product is evenly graded by weight; (2) that the compound-interest law held for the frequency curve. The experimental undertakings intended to show that for such typical substances as quartz sand, feldspar, flint, glass, brick, barite, and hematite which had been disintegrated by means of such typical mills as rolls, hammer mill, ball mill, etc., the following held: (1) The amount of material is dependent upon particle size, and not width of mesh, velocity of blow, etc. (2) The accuracy of measurement in the range used held for all sizes. (3) The practical methods would be applicable. It was shown that the usually employed method of sedimentation was excluded for the finer particles. A method consisting of suspension in glycerol contained in a counting cell was developed for the determination of particle sizes of different fractions. For the water dispersions no electrolyte was used as peptizer for quartz sand, feldspar, glass, and flint; Ca citrate was used for brick and barite; and Na arsenite for hematite. A new type of washing and settling chambers with tapered sides was designed which gave good agreement with Stokes' law. The experimental results are given in tabular and graphic form. In conclusion it was desired to see how well results checked the fundamental considerations: (1) for disintegrated products no general law holds for the particle-size distribution method and material; (2) the particle shape is not dependent upon its size if the same method of disintegration is used; (3) the compound-interest law did not hold for ball mill disintegration; (4) nothing was found that showed the particle shape varied with particle size. A bibliography of 74 references is given. (*C.A.*)

The plasticity of clay. B. S. SHVETZOV. *Trans. State Expt. Inst. Silicates* (Moscow), **21**, 15–20 (1927).—S. analyzes the Auerbach formula (F. Auerbach, Plasticitat und Sprodigkeit, *Ann. Phys. Chem.*, **45**, 277 (1892)) for plasticity. (*C.A.*)

BOOKS

Ullmann's Encyclopedia of Technical Chemistry. Vol. II. Auslaugapparate to Calcium carbide. F. ULLMANN. Second edition. Urban & Schwarzenberg, Berlin, 1928. Price 48 RM. H.H.S.

Great Chemists. E. J. HOLMYARD. Methuen & Co., London, 1928. Price 3*s* 6*d*. H.H.S.

Colloid Chemistry: Theoretical and Applied. Vol. II. Biology and Medicine. JEROME ALEXANDER. Chemical Catalog Co., New York. 1000 pages. Price $15.50.—This is a series of fifty-seven condensed papers. The advanced stages of research makes it quite impossible to take the work of so many and do much more than bind it together. The mere work of persuading so many outstanding investigators to put down their knowledge and opinions is now so great a task that nothing more should be expected. There are splendid chapters relating to the field of science and chemistry where the colloid holds such sway. Reviewed in *Can. Chem. Met.*, **13** [2], 52 (1929). E.J.V.

PATENTS

Process of producing titanium oxide from titaniferous iron ores. CARL RAYMOND WHITTEMORE. U. S. 1,699,173, Jan. 15, 1929. The process of preparing titanium oxide from titaniferous iron ores, which comprises reducing the iron content to iron sponge without fusion or sintering, cooling in a nonoxidizing atmosphere and separating the sponge and titanium content from the nonmagnetic portion, dissolving the treated ore with a solvent, separating the residue, heating the residue with an acid to 250°C in a digester to form titanium salts, lixiviating the mass with cold water after its having been disintegrated, hydrolyzing the solution to precipitate titanium hydroxide, separating the precipitate from the solution, and calcining the precipitate.

Zeolite. ALPHONS O. JAEGER AND JOHANN A. BERTSCH. U. S. 1,701,075, Feb. 5, 1929. Zeolites containing quadrivalent vanadium in nonexchangeable form.

Alumina; sodium aluminate; sodium sulphide. A. L. MOND. Brit. 300,184, Dec. 31, 1928. Clay, phonolite, leucite, etc., are treated with sulphuric acid or a mixture of sulphuric and hydrochloric acids. After separating insoluble matter, the solution is evaporated with an amount of sodium chloride equivalent to the sulphuric acid, and the residue is heated to 700°C, preferably in a rotary furnace in which the materials and the heating gases pass in the same direction. Hydrochloric acid is evolved. The sintered product is heated to 1000°C with carbon to produce sodium sulphide, sodium aluminate and some soda. The product is lixiviated. Some of sodium sulphide may be separated by crystallization, and alumina is precipitated by treatment with sulphuretted hydrogen or carbon dioxide, or a mixture of these gases. Further quantities of sodium sulphide may be separated by crystallization. The mother liquor, or the liquor before separation of sodium sulphide may be treated with carbon dioxide to separate sodium bicarbonate. If the clay, etc., has been treated mainly with hydrochloric acid, alkali sulphate may be added to the sintered product, and if only small amounts of hydrochloric acid have been used, bauxite may be added in order that the sintered mass may contain about equimolecular proportions of alumina and alkali sulphate.

Alkali and alkaline earth nitrates. KALI-INDUSTRIE AKT.-GES., C. T. THORSSELL, AND A. KRISTENSSON. Brit. 300,632. Jan. 9, 1929. The solution of nitrate and nitrite obtained by causing a solution or suspension of an alkali or alkaline-earth hydroxide or carbonate to trickle over the absorption towers of a nitric acid plant is freed from nitrite as by treatment with nitric acid and steam and then cooled say to 0°C to deposit a part of the nitrate in solid form. The mother liquor after being warmed to 15 or 20°C, as by passage in countercurrent to further nitrate solutions to be cooled, is re-used in the absorption process after addition of further hydroxide or carbonate.

General

Our financial deficit. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **8** [2], 31–32 (1929). E.J.V.

American Ceramic Week. ANON. *Brick Clay Rec.*, **74** [2], 86–92; [4], 248–62 (1929).—The American Ceramic Exposition and meetings of the Common Brick Mfrs.' Assn. and Structural Clay Tile Assn. in connection with the Annual Meeting of the AMERICAN CERAMIC SOCIETY, Chicago, February 4–9, are discussed in seven articles. E.J.V.

Ohio Brick and Tile Association. ANON. *Brick Clay Rec.*, **74** [2], 98 (1929).—A brief account of the fifth annual convention held in Cleveland, Jan. 8, 1929. Speakers included Clayton Grandy, Major Lent, Ralph Stoddard, and W. C. Denison. E.J.V.

N.B.M.A. launches research program. ANON. *Brick Clay Rec.*, **74** [4], 263–64 (1929).—The research program of the National Brick Mfrs. Assn. has been largely expanded, following a proposal made at Atlantic City last year for a definite program which would be comprehensive, well organized, and which will provide opportunity for the coöperation of the plant operator, the technical expert, and manufacturer of equipment. For the successful fulfilment of this program, 13 committees have been appointed to investigate special problems in the manufacture of heavy clay products. The committees named have the following headings: nomenclature and material classification; clay winning; transportation and storage of raw materials; preparation of raw materials; pugging and machining, stiff-mud process; pugging and machining, soft-mud process; pugging and machining, dry-press process; drying and drier design; firing and kiln design, periodic kilns; firing and kiln design, continuous kilns; power generation and application; clay plant economics; general data. E.J.V.

Miscellaneous mineral production in Nova Scotia during 1928. J. P. MESSERVEY. *Can. Chem. Met.*, **13** [1], 25 (1929).—Clay beds suitable for the manufacture of clay products exist in various parts of the Province. Vitrified tiles and sewer pipes are made at New Glasgow, and all classes of building tiles are manufactured at Avonport. Building brick is made at Pugwash, New Glasgow, Lantz, Elmsdale, Avonport, Bridgetown, and Mira. The fire clay used at the Steel Works, Sydney, is obtained from Shubenacadie, and the alumina fire clay from Middle Musquodoboit, Nova Scotia, for making stove linings. Production for the year ended Sept. 30, 1928, for Nova Scotia is as follows:

	1928
Brick, common	6,803,574 (8 in.)
" clay	242,592 (9 in.)
" fire	26,000 (12 in.)
" silica	2,071,301 (9 in.)
Diatomaceous earth	645 tons
Dolomite	18,510 "
Fire clay	2,378 "
Ganister	1,530 "
Gypsum, crude	972,211 "
" calcined	8,720 "
Limestone	67,919 "
Molding sand	30 "
Sandstone	3,700 "
Sewer pipe	9,856 "
Silica	8,604 "
Silica cement	913 "
Tiles, drain	97,060 ft.
" interlocking	665,843
" partition	699,549

E.J.V.

Feldspar producers combine. ANON. *Glass Ind.*, **10** [2], 47 (1929).—The consolidation of a number of important units in the feldspar industry has been consummated, effective Feb. 1, 1929, under the name Consolidated Feldspar Corp., with headquarters at Trenton, N. J. Already included in the new organization are the Maine Feldspar Co., Dominion Feldspar Co., Feldspar Dept. of the Isco-Bautz Co., Inc. The combination will include the above concerns and the Pennsylvania Pulverizing Co.'s feldspar mill at Rochester, N. Y., and possibly other producers and grinders. The new consolidation will make it possible to supply any grade of feldspar any user may specify and to give a wide range of the mineral for all consumers, and result in the completion of a well rounded out feldspar organization controlling ample supplies of raw material and adequate milling facilities in each of the major fields of operation. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **54** [620], 274–76 (1929); *Glass Ind.*, **10** [2], 35 (1929).—A report of the December meeting at London, at which the following papers were read: "Manufacture of Laminated Glass," by W. R. Tyttleton; "Detection of Iron Oxides in Glass Sands," and "Reduction of Glasses in Hydrogen," by J. T. Randall and R. E. Leeds; and "Analysis of Phosphate Glasses," by Violet Dimbleby. At a meeting in Manchester in January papers read were: "Volatilization from Soda-Lime-Silica Glass at High Temperatures," by W. E. S. Turner, Violet Dimbleby, and W. H. Howes; and a discussion of the methods to be submitted to the Standards Committee in connection with "Testing Glass Bottles for Chemical Durability." E.J.V.

Grading employees by statistics. R. G. BLANC. *Abrasive Ind.*, **10** [2], 76 (1929). E.P.R.

Clay products and nonclay refractories census of manufacturers. ANON. *Mfrs. Rec.*, **95** [5], 47 (1929).—The Department of Commerce announces that, according to data collected at the biennial census of manufacturers taken in 1928, establishments in the U.S. classified in the "Clay Products and Nonclay Refractories" group of industries reported for 1927 products valued at $430,305,900, a decrease of 6.3% as compared with $459,031,170 for 1926. The total for 1927 is made up as follows: clay products other than pottery, $295,213,565; pottery, $111,355,441; nonclay refractories, $23,245,678; other nonclay products, $491,216. E.P.R.

South's clay resources. ANON. *Mfrs. Rec.*, **95** [5], 48 (1929).—Some of the country's leading ceramists have emphasized the superior advantages offered by the south to the clayworking industry. Raw materials in abundance are to be found in many areas from Md. to Tex. Deposits are located convenient to fuels, with available power and transportation and plenty of labor. The clay belt extending across Ga. is said to be the largest known kaolin area in the world. The ceramic industry of the south, although comparatively few years old in its modernized development, has made rapid progress. Complete data are not available for the south as a whole, but they are summarized by states, as to resources and extent of development of the ceramic industry now under way in this section. E.P.R.

Recent development in the southern ceramic industry. ANON. *Mfrs. Rec.*, **95** [5], 49 (1929).—Activity in the south's ceramic industry in 1928, embracing plant enlargements, consolidations and contemplated new clayworking enterprises, is indicative of the continuous steady expansion of substantial character which this section has been experiencing for the past several years. It is one phase of the south's industrial growth, which having nothing of the spectacular element, is nevertheless receiving increasing attention. E.P.R.

Ceramics in Texas. GEOFFREY E. GOVIER. *Mfrs. Rec.*, **95** [5], 53 (1929).—With the exception of brick, hollow tile, and sewer tile, all the ceramic materials used in the construction work so active in Texas are brought into Texas from other states. One clay expert who has made a careful investigation states that he has found practically every known variety of commercial clay in Texas, and in addition, a number of deposits of feldspar, flint, and sand. Usually, these deposits are close to the surface, and can be mined cheaply. In the San Antonio district these various raw materials occur in such close proximity that a plant using any combination of them and located anywhere within the area would have the advantage of a minimum of assembly charge. Texas factories have been manufacturing brick, hollow tile, and sewer tile for years, and their products are of the highest quality. Several very successful glass factories are also in operation, and there are a few small potteries producing specialties such as flower pots, jars, Mexican ornamental pottery, and bric-a-brac. Until recently,

however, there has been little or no effort made to introduce the manufacture of a fairly complete line of ceramic goods. E.P.R.

Recent advantages in boiler firing. M. D. JONES. *Blast Fur. Steel Plant*, **17** [1], 117–18 (1929).—The high rate of combustion obtainable with turbulent pulverized-coal burners has been made possible by the development of furnaces that will permit higher rates of heat liberation than allowable when using furnaces of brick construction. The demand for a furnace construction capable of withstanding the increased temperature due to increased rates of heat liberated per cubic foot of furnace volume led to the development and adoption of water-cooled furnaces. The problem of removing the ash in pulverized-coal fired furnaces has resolved into designing furnaces which will permit the ash to be removed in a liquid form or in a granular state. In the Bailey hopper-bottom furnace of water-cooling tubes covered with smooth cast-iron blocks, the ash may chill but not adhere to the furnace bottom, or the ash may run into the ash pit in liquid form where it can be quenched and broken up by a water spray for easy removal by means of a sluice conveyer. This construction is adapted to coals of any percentage of ash and of any ash fusion temperature. F.P.H.

Advantages in boiler firing with stokers. A. F. STROUSE. *Blast Fur. Steel Plant*, **17** [1], 119–21 (1929).—Greater output requires increased stoker efficiency and for change of boiler design from the wide, low boiler to the narrow, high boiler. This change came about, due to increasing land values and building foundation costs for those plants in densely populated sections. F.P.H.

Ceramic men urge tariff increase. ANON. *Ceram. Ind.*, **12** [2], 227–30 (1929).—The procession of representatives of the ceramic industry that appeared before the House Ways and Means Committee, Jan. 10, 11, and 12 advocated a sweeping upward revision in the tariff schedule designated as clays, earthenware, and glassware. F.P.H.

Research and a greater gas industry. ARTHUR D. LITTLE. *Gas Age-Rec.*, **62** [16], 549–51 (1928). F.P.H.

New under-voltage devices which operate after time interval. ANON. *Rock Prod.*, **32** [3], 122 (1929).—To meet the demands for a device to protect against failure of voltage in power circuits after a suitable interval has elapsed, the General Electric Co., Schenectady, N. Y., has introduced two new equipments bearing the designations MG-2 and PF-2. These are especially designed to trip the breaker in the circuit only after a suitable time interval, and will not cause interruptions to service when momentary voltage dips occur. F.P.H.

Experimental engineering without equipment. ARTHUR M. SHAW. *Eng. News-Rec.*, **101** [6], 210–12 (1928).—Several examples are cited from experience to show that improvised apparatus often gives satisfactory answers to perplexing field problems. Examples include the testing of cement, determining of concrete flowability, and vibration of a building. L.A.P.

Corrosion of boilers checked by electrochemical system. L. O. GUNDERSON. *Eng. News-Rec.*, **101** [6], 299 (1928).—A system for the prevention of corrosion by counteracting electrolysis and galvanic action, is described. An electrochemical polarization system, applied to locomotives, gives good results. The system requires that the imposed direct current be supplied to the electrodes whenever the locomotive is in service, so as to maintain enough excess hydrogen to react with the oxidizing agents entering with the boiler feed water. It is applicable also to boilers of water-works. L.A.P.

Limiting temperature in central-station operation. V. T. MALCOLM. *Mech. Eng.*, **50** [2], 137–42 (1928).—M. believes that at each temperature of a metal under test there is a stress which if exceeded will cause fracture, though equipment may give

satisfactory service, operating at this temperature with loads greater than the critical stress, for many years. His conclusions are that the design of equipment must be based upon the strength of metals at operating temperatures, over long periods of time, and that other properties such as thermal expansion, thermal conductivity, chemical stability, resistance to wear and abrasion, etc., must receive greater attention than in present engineering practice. These latter factors will probably govern actual design, but the first and basic requisite is that of physical strength at the proposed temperature. Ten charts, giving data on certain alloys that M. considers safe for operation at 1000°F are given. L.A.P.

Report on reheat factors. E. L. ROBINSON. *Mech. Eng.*, **50** [2], 155–56 (1928).—The reheat factors for a new steam chart have been prepared by a process of computation devised to utilize all the accuracy of the large-scale diagram. Calculations were made from a series of condition curves at 80% uniform stage efficiency. It is assumed that the change of temperature along the curve is proportional to the change of total heat. This assumption is satisfactory in the superheated region, but in the wet region a correction factor is applied. The aim of the calculations have been to locate the final point of the condition curve within 0.1 B.t.u. From this curve, reheat factors are quickly found by comparison of actual with adiabatic heat drops. L.A.P.

Viscosity of lubricants under pressure. MAYO D. HERSEY. *Mech. Eng.*, **50** [3], 221–32 (1928).—Five oils, typical of the better known classes of animal, vegetable, paraffin base, naphthene-base, and blended oils were studied. The maximum pressures and temperatures reached were, respectively, about 4000 kg. per sq. cm. and 140°C. Lard oil solidifies abruptly on passing through a critical pressure which, at 22°C is about 1550 kg. per sq. cm. The paraffin-base oil shows a somewhat similar effect. For all of the oils tested except, notably, lard oil it was found that the temperature coefficient of viscosity is considerably increased under moderately high pressures. These and other facts brought out may have numerous applications. L.A.P.

Laboratory investigations of the National Sand and Gravel Association. ANON. *Pit and Quarry*, **17** [8], 61–63 (1929).—The article describes the various researches under way in the laboratories. The first investigation undertaken consisted of tests on the effect of grading of coarse aggregate on its void content. The second investigation is along the same lines, except that sand and other fine aggregate are being studied. The third research problem involved a study of the finer sizes, such as pea gravel, in a coarse aggregate. Compression and transverse tests of concrete for a wide range of conditions are being carried out. General studies are being conducted on sands exhibiting unusual characteristics when used in concrete and mortar. Studies on what amounts of soft, friable, flat, and elongated pieces are harmful in gravel used for concrete are now under way. Reports of the results will be made available as soon as the investigations are complete. R.G.E.

Action of silica dust in the lungs. P. HEFFERNAN. *Brit. Clayworker*, **37** [440], 361–64 (1928).—The harmful effects of colloidal silica appear to be due to its powerful potentialities as a colloid rather than to any toxicity of the silica ion. Pulmonary silicosis is probably caused by the colloidal action of hydrated silica, formed through the pulmonary tissue. There is evidence to show that the activity of colloidal silica in the lungs may be prevented by protecting the silica dust with a coating of a substance which is known to coagulate colloidal silica. Such substances are clay, carbon, shale dust, etc. Possibly other colloids, *e.g.*, stannic acid sol, may be capable of acting in the tissues in a similar manner to hydrated silica. R.A.H.

Joint meeting of English and German Societies of Glass Technology. ANON. *Glass*, **5** [6], 251 (1928); for abstract see *Ceram. Abs.*, **7** [10], 728 (1928). A.J.M.

Improved thermostatic control for leers. ANON. *Glass*, **5** [8], 356 (1928).—The

principle underlying the operation of the controller is the differential expansion, under varying temperatures, of a nickel tube and a fused quartz rod. This relative movement is small, but, by simple and positive means, the movement is multiplied and employed to operate upon the fuel burner valve, opening or closing this to admit more or less fuel as required to maintain the desired temperature in the leer. Actually the device consists of two units, the expansion, and the valve operating units, but although, as used on a leer installation, these two are fitted close together, it is not necessary that this be done. They can be a considerable distance apart, the only connection required between them being a small diameter tube. A.J.M.

Italian chemical societies' amalgamation. ANON. *Chem. and Ind.*, **48**, 65 (1929).—The Society of Industrial Chemistry at Milan and the Italian Association of General and Applied Chemistry at Rome have amalgamated under the title "Associazione Italiana di Chimica," with headquarters at Rome. Both societies were founded in 1919, the official Milan organ being the *Giornale di Chimica Industriale ed Applicata*, and that of Rome the *Annali di Chimica Applicata*. H.H.S.

Canadian gypsum imports to U.S. ANON. *Chem. and Ind.*, **48**, 85 (1929).—The U. S. Treasury has ruled that Canadian gypsum is dutiable at 30% *ad valorem*, on the basis of its classification as crushed gypsum. This ruling may be viewed as a compromise between free entry as crude material and a duty of $1.40 as ground gypsum. H.H.S.

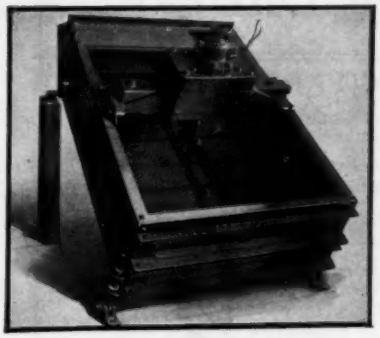
BOOKS

Nitroglycerine and Nitroglycerine Explosives. PHOKION NAOUM. Translated by E. M. Symmes. Williams and Wilkins Co. 469 pp. Price, $7.00 (1928). Reviewed in *Min. and Met.*, **10** [266], 104 (1929).—N.'s book, when published in Germany in 1924, was welcomed by all those engaged in the explosives industry. As director of the scientific work of one of the largest dynamite factories, his experience admirably fitted him for the task of preparing a comprehensive account of the manufacture and properties of this class of explosives. Nitroglycerine, the homologous and related nitric esters, and the nitroglycerine explosives are discussed. The technology of nitroglycerine manufacture is treated with great fullness, special attention being given to recent improvements. The general treatment of the esters reviews those of theoretical interest, as well as those of commercial importance. The section on explosives is a valuable survey of the present state of the art. F.P.H.

Annual Report of Director of Bureau of Mines. SCOTT TURNER. 57 pp. (1928).—A total of 109 printed reports and 13 reprints was issued during the year. The mimeographed publications included 62 reports of investigations and 29 information circulars. In reviewing the year's accomplishments of the Bureau it should be recorded that the Bureau continued its educational campaign designed to bring about safer and more healthful working conditions among the more than a million employees of the mining, quarrying, metallurgical, and oil and gas industries. In the field of metallurgy the Bureau continued to contribute to the practical conservation of the nation's mineral resources through the development and improvement of methods for recovering more of the mineral content of ores, with attendant lessening of the cost of recovery. Increasing attention is being given to research looking to the more efficient mining treatment and utilization of the numerous important nonmetallic minerals which enter so largely into the construction of buildings and highways. The Bureau is investigating the various methods used in geophysical prospecting, that interesting development which is making possible the location of mineral deposits heretofore unknown. The Bureau has continued to study problems of efficiency in the use of fuels. A short description of the various problems studied in the technologic branch and what has been accomplished is included. R.A.H.

Book Review

Soluble Silicates in Industry. JAMES G. VAIL. 443 pages, 185 figures including photographs and microphotographs, 123 tables. Published by Chemical Catalog Co., Inc., 1928. Price $9.50.—The great variety of uses to which silica is put in industry is little appreciated by the average person, and V., who is chemical director of the Philadelphia Quartz Co., has gathered together a vast amount of information on silica and its various compounds which should be of distinct value to the chemist and manufacturer. The work is presented in a readable form intelligible to those unfamiliar with the intricacies of the subject, and yet sufficiently technical to be of great value to the experienced chemist. Exhaustive tables pertaining to silicates and their industrial uses are included with charts, diagrams, photographs, and microphotographs illustrating the subject matter. The book is an instigation for further research along these lines by furnishing a well-digested survey of the progress already made in the field and by pointing out directions in which further investigation is essential. A bibliography is included. The book is divided into twelve chapters: (1) introduction which treats of the historical development of soluble silicates, their manufacture, and industrial uses; (2) constitution of silicate solutions: including the important role which colloidal silica plays in the industrial silicate solutions and the occurrence of colloidal silica in nature; (3) definite soluble silicates: compounds which may exist in solution, as well as the nature of the silica or alkali above the amounts thus accounted for, are matters of considerable consequence to industrial silicate solutions and are clearly defined in this chapter; (4) reactions: so many substances react with and precipitate silicate solutions it is almost safe to assume that a clear viscous solution of any alkaline silicate contains nothing but silica, alkalis, and water. Commercial solutions are viscous and somewhat colloidal, so it is possible for small quantities of various substances to be present; (5) preparation: reactions which give rise to soluble silicates are grouped as wet and dry methods, dry methods of preparation of soluble silicates being limited to materials of greater purity than wet methods; (6) commercial forms and properties: the great variety of forms in which soluble silicates are marketed are divided into three groups, anhydrous silicates as glasses or powders formed by fusion processes, hydrous solids formed by hydration of glasses or evaporation of solutions, and the solutions; (7) silicate cements: soluble silicates are at least mentioned in every compendium of formulas for cements; this chapter indicates the nature of the variables and is an endeavor to assist the person who wishes to formulate a mixture for a given use, rather than the presentation of a set of recipes for use without experimental preliminaries. Cements in which soluble silicates are of use are classified as (*a*) those which set primarily by loss of moisture from the silicate solution, (*b*) those depending on a reaction with the silicate to become firm, (*c*) those in which silicate is used to modify the properties of other cements; of special interest to abrasive engineers is the portion of this chapter devoted to the manufacture of silicate wheels; (8) adhesives: this chapter indicates the close analogy between adhesive characteristics of animal glues and silicate adhesives, various methods and uses of silicates as adhesives being described; (9) sizes and coatings: the nature and uses of silicate films is explained; (10) deflocculation and detergency: the characteristics of soluble silicates which affect their detergent action are explained in this chapter; (11) gelatinous films and gels: the properties of gels are changed by altering the amount of liquid present when formed; the number and size of the interspaces affect porosity, capillarity, and reaction rate of processes which occur at the surface; for convenience in grouping the uses of siliceous gels in industry, an arbitrary distinction has been made between gels which embody the entire reacting liquid and those which form as films; (12) additional uses. E.P.R.



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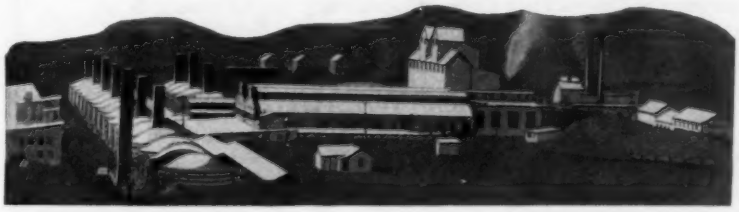

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Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS
Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate

THREE INSTRUCTORS *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering

TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering

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MORGANTOWN, W. VA.

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TORONTO, CANADA

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OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

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TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

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Curriculum—Ceramic Engineering — *Head of Department:* J. W. WHITTEMORE

UNIVERSITY OF CINCINNATI

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Founded 1926 — *Head of Department:* HAROLD S. NASH

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Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS

Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

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Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*

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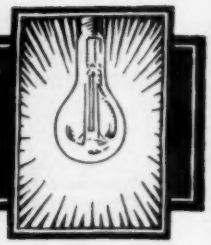

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 8 **April, 1929** **No. 4**

EDITORIALS

CERAMIC EXPOSITIONS

Expositions are educational in purpose and result. They do not have advertising and sales as their prime objectives, although these are valued results. Expositions do more than advertise; they demonstrate. They are in fact "sales engineering." Their purpose is to teach facts to the ultimate purchaser regarding the art, quality, and utility of the wares exhibited.

A laboratory organization would not be complete if it did not have as one of its most important divisions what is called "sales engineering" or "demonstration." No factory research organization is worth while that does not demonstrate to the ultimate purchaser the value there is in the wares produced in the factory. This is educational and inspirational to the research workers. In no other way can they obtain the essential objectives for laboratory and plant studies. Just as "plant applications" are essential to college and institute investigators so "sales applications" are to the manufacturing investigators.

Expositions have value also in comparative studies of the needs of the ultimate purchaser. There are broader visions and conceptions obtained in showing wares in competition. Expositions are as educational to the producer as to the consumer.

The sales feature of ceramic expositions lies in making the purchasing public conscious of the value and utility of the wares shown. Printed words and pictures do not impress the mind of the uninformed as do the actual wares. National and direct advertising are necessary educational mediums. Displays in stores and in permanent exhibits are productive. But there is no display as effective as a featured exposition of competitive wares. Seeing is knowing and there is no medium equal to visual demonstration as a means of giving information.

The AMERICAN CERAMIC SOCIETY would not be adequately promoting the arts, science, and technology of ceramic ware production if it did not promote expositions. This the SOCIETY should do for the educational value of expositions to its members, and also to create a larger demand for the products they make.

A national ceramic exposition such as was held during the Ceramic Week in Chicago this winter brings together the ceramic products of all the states. No local or state exposition can have the larger value there is in a national exposition. But there is also a value in ceramic expositions by states and communities that cannot be obtained in national expositions.

The profits to the manufacturers and to the schools of a given state in a well-advertised exposition of the ceramic wares produced in that state would result in greater solidarity in support by the manufacturers and the public of ceramic education and research. Community pride and ambition would be cultivated. The states' industrial possibilities and values would be demonstrated as they can be in no other way, and certainly not in a national exposition.

We strongly urge local and state expositions as well as national expositions of ceramic ware because the industrial and scientific status nationally is dependent on their strength and aggressive promotion by states.

This SOCIETY would be remiss if it did not laud the New Jersey Ceramic Exposition held at Rutgers University[1] opening March 8th and extending through the week of the 10th. Ohio State had such an exposition in 1925 which, together with coördinating activities, did much to stimulate interest in ceramic education and research in Ohio.

The Clay Product shows in Chicago in 1912 and 1913 and the clay building material show held in Canton this March awakened consciousness in the ultimate purchasers to the value of clay products more effectively than would the same effort and money expended in paper advertising.

Another worth while exposition of ceramic wares would be an itinerant show or demonstration.

No exposition will be worth while, however, unless the "public" attends.

[1] See this *Bulletin*, p. 85.

This involves direct mail, radio, newspaper, and display advertising of the show, and the wider the advertising the greater the value.

If this sort of activity should by some persons be deemed outside of the scope of the AMERICAN CERAMIC SOCIETY, we suggest that the educational features for the producer and the consumer, the "sales demonstration" phase of research work, are of great importance to effectiveness in ceramic research and education.

BRITISH CERAMISTS OUR GUESTS

It is the New Jersey Clay Workers Association, American Refractories Institute, Ohio Ceramic Industries Association, the Canadian Clay Products Association, and the AMERICAN CERAMIC SOCIETY who will be the hosts in general and the several local sections in particular instances.

The guests are members of the Ceramic Society and the Refractories Association of Great Britain.

Only three weeks to tour New Jersey, Pennsylvania, Maryland, Ohio; a part of the crowd will go to St. Louis and Mexico, Mo., and Vandalia, Ill., with a flying trip to Toronto and across New York State. This grand rush starts April 29 from New York City and concludes Saturday, May 18.

Some of our English guests are going to stay a while longer "on their own"; others are leaving America by way of Montreal and Vancouver.

This occasion is one in which all Americans should participate who can. It is an opportunity to get acquainted with the cream of the British Isle ceramists, men of the best plant and scientific training. It is an opportunity also to see our most up-to-date plants and meet many of our most successful ceramists.

The AMERICAN CERAMIC SOCIETY is combining with this the customary "Summer Meeting Plant Tour."

Occasions of this kind are what are needed to put one's self on top with the best. They knock us out of our ruts and make us broader in knowledge and outlook. It will pay anyone to join in on this British Ceramists tour of a wee bit of this continent.

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM FEBRUARY 1 TO MARCH 1

Corporation

Coxon Belleek China Co., Wooster, Ohio, Edward B. Coxon, representative.

International Lead Refining Co. (Anaconda Zinc Oxide Dept.), 151st and McCook Ave., East Chicago, Ind., F. O. Case, representative.

Rex Products and Manufacturing Co., 451 W. Larned, Detroit, Mich., W. W. Davidson, representative.

Personal

George Arras, 32 S. Peoria St., Chicago, Ill., Superintendent of Enameling Dept., Quadrangle Mfg. Co.

Arthur James Aubrey, 462 Crandall Ave., Youngstown, Ohio, Sales Manager, Lee Air Heater Co.

Albert Lorrimer Brigger, 428 W. 40th Place, Los Angeles, Calif., President of California Testing Laboratories, Inc.

Thomas A. Carothers, National Marking Machine Co., 508 S. Dearborn St., Chicago, Ill.

Harry E. Cave, 2120 Natchez Ave., Chicago, Ill., Vice-President, General Color Products Co.

Ira H. Chandler, 648 Laurel Ave., Zanesville, Ohio, Manager of Faience Dept., Mosaic Tile Co.

C. O. Daniels, President, Greendale Brick Co., Logan, Ohio.

Hector Desjardins, 3960 St. Hubert St., Montreal, Canada, General Manager, Montreal Terra Cotta Co., Ltd.

Robert R. Emmitt, 1107 Charles St., McKees Rocks, Pa., Industrial Engineer, Columbia Gas and Electric Corp. (Pittsburgh Group).

Louis J. Friedl, 4716 Broadale Ave., Cleveland, Ohio, General Manager, Cleveland Pottery Co.

Robert T. Hendrich, 6007 Euclid Ave., Cleveland, Ohio, Representative, Titanium Alloy Mfg. Co.

Thomas J. Hughes, 573 S. Main St., Washington, Pa., Chief Chemist, Tygart Valley Glass Co.

Silvanus V. Hunt, Enameling Superintendent, General Steel Wares, Ltd., Toronto 2, Ontario, Canada.

Flavius B. Jones, 435 Sixth Ave., Pittsburgh, Pa., Director of Industrial Gas Sales, Equitable Gas Co.

Paul F. Larson, Y. M. C. A., Elgin, Ill., Assistant Ceramist.

William T. Mahoney, 2057 Fulton St., Chicago, Ill., Vice-President, Wolff Co.

Herbert G. McLear, 141 Broadway, New York City, Vice-President, Green Hill Mining Co.

Albert Oesterle, 4635 E. 52nd Drive, Maywood, Calif., Enameling Superintendent.

Robert Richardson, 500 Orchard Grove Ave., East Liverpool, Ohio, Superintendent of Research, Babcock & Wilcox Co.

Keiichi Shimizu, Onoda, Yamaguchi-Ken, Japan, Chemical Engineer, Onoda Cement Co.

Carl G. Stuecken, 9730 Glayes, Detroit, Mich., Enameling Superintendent.

W. W. Swengel, Manager, Royalton Face Brick Co., Middletown, Pa.

James Huston Varner, 4529 Valley Road, Fairfield, Ala., Superintendent, Harbison-Walker Refractories Co.

Harry Ernest Wangland, Enameler, General Steel Wares, Ltd., Toronto 2, Ontario, Canada.

Theodore Whittelsey, Old York Road, Ringoes, N. J., Consulting Chemist, Johns-Manville Corp.

John Frederick Wilde, 635 N. Main St., Pomona, Calif., Superintendent and Ceramist, Pomona Tile Manufacturing Co.

STUDENT

John J. Corry, Iowa State College, Ames, Iowa.

John Gallup, New York State School of Clayworking and Ceramics, Alfred, N. Y.

H. Edward Hoffa, University of Illinois, Urbana, Ill.

Ercel B. Hunt, Iowa State College, Ames, Iowa.

Membership Workers' Record

CORPORATION	
H. G. Thomson	1
Office	2
Total	3

PERSONAL	
Marion W. Blair	1
J. E. Brinkerhoff	1
H. B. DuBois	1
F. C. Flint	1
Leon J. Frost	2
L. E. Geyer	1
Frank E. Hodek, Jr.	1
J. W. Hoehl	1
R. D. Landrum	1
Charles C. Leigh	1
A. Malinovszky	1
J. S. McDowell	1
W. F. Mooney	1
Henry Oesterle	1
R. E. Polk	1
Ross C. Purdy	1
T. Yoshioka	1
Office	8
Total	26

STUDENT	
Paul E. Cox	2
R. K. Hursh	1
F. Westendick	1
Total	4
Grand Total	33

NEWS FROM MEMBERS OF THE SOCIETY

The Amherst Foundry Co., Ltd., of Amherst, N. S., has become a part of the Enamel and Heating Products Co., Ltd. Mr. C. A. Lusby is president of the new company.

Edwin P. Arthur has moved from Morgantown, W. Va., to 2074 Santa Rosa Ave., Pasadena, Calif.

Leon B. Bassett has moved from Westerly, R. I., to Milton, Wisc.

James R. Beam, formerly a student at Ohio State University, may now be addressed at 126 Gaius St., Bucyrus, Ohio.

The Belleville Enameling and Stamping Co. has been sold to the Peerless Enamel Products Co. of Belleville, Ill.

Frank W. Bryson is with the Barboursville Brick and Tile Co., Barboursville, W. Va. He was formerly with the Wellston Clay Products Co., Wellston, Ohio.

Matthew W. Butler, who has been with the Glascote Co. of Cleveland, is now connected with the Frigidaire Corp. in Dayton, Ohio, and may be addressed at Apt. B-12, 229 W. Herman Ave.

H. N. Clark is connected with the Refractory and Engineering Corp., 50 Church St., New York.

W. H. Cook, formerly superintendent of the Empire China Co., Burbank, Calif., is now president and general manager of the Cook China Co., 644 S. Griffin Ave., Los Angeles, Calif.

George R. Daniel is now connected with Mellon Institute of Industrial Research, Pittsburgh, Pa. His former address was Ironton, Ohio.

The name of **Dolomite Products Co.** of Cleveland, Ohio, has been changed to Dolomite, Inc.

W. E. Dornbach, formerly of the General Refractories Co. of Philadelphia, is now at 706 Edgewood Rd., San Mateo, Calif.

Whitcomb B. Fairfield is connected with the Henger-Fairfield Co., Cleveland, Ohio. He had been assistant general manager of the General Color Products Co., Chicago, Ill.

The Farber Fire Brick Co. has recently been merged with the North American Refractories Co. at Farber, Mo.

Mabel C. Farren gives her address as Palm Crest Apts., 1109 Ingraham St., Los Angeles, Calif.

Gladding, McBean and Co. has changed its address from Dexter Horton Bldg., to 1500 First Ave., South, Seattle, Washington.

Max L. Gunnarson and V. K. Haldeman are with the Haldeman Tile Mfg. Co. and may be addressed at P. O. Box No. 3, Hollydale, Calif.

Max Hermann, who was formerly with the Mansfield Vitreous Enameling Co., Mansfield, Ohio, is now assistant in the enameling plant of the A. J. Lindemann and Hoverson Co., Milwaukee, Wisc.

J. W. Hixson of the Atlantic Terra Cotta Co. has been transferred from the Perth Amboy plant to the New York office at 19 West 44th St.

The name of **Hollow Building Tile Assn.** has been changed to the Structural Clay Tile Assn. with offices at 1400 Engineers Bldg., Chicago, Ill.

Tajamul Husain, a former student at Ohio State University, is now at the Engineering Experiment Station at Roseville, Ohio.

The Inland Lime and Stone Co. of Manistique, Mich., now includes the former White Marble Lime Co. and the Manistique Lime and Stone Co.

Karl M. Kautz, formerly of Shelby, N. C., is now with the Abingdon Sanitary Mfg. Co., Abingdon, Ill.

Frobisher T. Lyttle is doing colored glaze research work for the Weller Potteries at Zanesville, Ohio. He was formerly with the Western Stoneware Co. of Monmouth, Ill.

Edward E. Marbaker, who has been Industrial Fellow at Mellon Institute, is now with the Industrial Research and Engineering Co., 7325 Penn Ave., Pittsburgh, Pa.

H. K. Mitra of the University of Pittsburgh has moved to Washington, D. C. His address is 2926 Upton St., N. W.

L. M. Munshaw is now employed at the Haeger Pottery, Dundee, Ill. He was formerly with the American Terra Cotta and Ceramic Co., Terra Cotta, Ill.

J. A. Nagle has accepted a position with the Carling Tile Co. of Macon, Ga.

Joseph W. Parker, Jr. has changed his address from 1429 Sante Fe, Los Angeles, to 1107 Oak St., South Pasadena, Calif.

F. K. Pence Tile Co. replaces The Paducah Tile and Pottery Co.

L. W. Penfield, who was formerly connected with the W. A. Riddell Co., Bucyrus, Ohio, can now be addressed at 36 Euclid Ave., Willoughby, Ohio.

Richard E. Reif has moved from Robinson, Ill., to 1212 Wilmington Ave., New Castle, Pa.

Leslie Sample has changed his address from Akron, Ohio, to 800 Lincoln Ave., Evansville, Ind.

Frank C. Schultz is now with the New Mexico Clay Products Co., Albuquerque, N. Mex. He was formerly with the Liberty Fuel Co., of Latuda, Utah.

The name of the **A. A. Simonds-Dayton Co.** of Dayton, Ohio, has been changed to Simonds Worden White Co.

W. J. Spielman has moved from Clyde, Ohio, to R. R. 1, Piqua, Ohio.

George H. Spencer-Strong has moved from Mansfield, Ohio, to 403 E. Washington St., Sandusky, Ohio.

Allen G. Walton has recently been elected president of the Sand-Lime Brick Assn. He may be addressed at the Manufacturers Club, Broad and Walnut Sts., Philadelphia, Pa.

Curtis R. Watters, formerly employed at the Ferro Enamel Supply Co., of Cleveland, is now in the enameling department of the American Radiator Co. Buffalo, N. Y.

Daniel D. Wheeler, formerly a student at Iowa State College, is now at the College of Mines, University of Washington, Seattle.

George A. Wills of Columbus, Ohio, is now located in Washington, D. C., at 2210 E Street, N. W., Apt. 1.

CONSTITUTION AND BY-LAWS OF THE AMERICAN CERAMIC SOCIETY

Constitution

Article I

(1) This SOCIETY shall be known as THE AMERICAN CERAMIC SOCIETY.

(2) The object of the SOCIETY is to advance the ceramic arts and sciences by meetings for the reading and discussion of papers, the publication of scientific literature, and other activities.

Article II

Membership

(1) The SOCIETY shall consist of Honorary, Ex officio Honorary, Active, Life, Associate, Corporation, Life Corporation and Industrial Association Members.

(2) Honorary Members must be persons of professional eminence, elected in recognition of their achievements in ceramic art or science. Their number shall not exceed ten.

(3) Honorary Members shall be nominated by at least ten Active Members and unanimously approved by the Board of Trustees. Such nominations shall be placed before the SOCIETY at an annual meeting, and must receive the affirmative vote of at least 90% of those voting, by letter ballot, at the next succeeding annual election.

(4) Ex officio Honorary Members must be such officers of such other associations and societies as shall be unanimously designated by the Board of Trustees, the name of the person holding such office appearing on the SOCIETY roster as Ex officio Honorary Member during the term of his incumbency only.

(5) Active Members are Associate Members who have been enrolled twenty-four months. This change in grade occurs automatically.

(6) Life Members must be those members, Active or Associate, who make single payment of an endowment fee as prescribed in Article III. Life Members shall have the same rights as Active Members.

(7) Associate Members must be persons interested in the ceramic or allied industries.

(8) Corporation Members must be persons, firms, or corporations who, being interested in the SOCIETY, make such financial contributions for its support as are prescribed in Article III. Their membership shall become operative on payment of dues as prescribed in Article III.

(9) Life Corporation Members must be persons, firms, or corporations who make

single payment of an endowment fee as prescribed in Article III. Life Corporation Members shall have the same rights as Corporation Members.

(10) Industrial Association Members must be organized groups of manufacturers, who being interested in the advancement of ceramic arts and sciences shall make, for this purpose, such financial contributions as are prescribed in Article III.

(11) All Honorary, Ex officio Honorary, Active, Life, Associate, Corporation, Life Corporation, and Industrial Association Members shall be equally entitled to the privileges of membership, except that only Active, Life, one representative of each Corporation Member, and one representative of each Life Corporation Member shall be entitled to vote. Such representative shall be officially designated by the person, firm or corporation represented. Only Active and Life Members shall be entitled to hold office. The roster of each grade of membership shall be printed separately in at least one publication issued by the SOCIETY annually.

(12) Any person may be expelled from any grade of the Membership of the SOCIETY if charges signed by five or more Active or Life Members be filed against him or her, and if the Board of Trustees examine into and sustain said charges by a majority vote. Such person, however, shall be notified of the charges against him and be given a reasonable time to appear before the Board of Trustees or to present a written defense before final action is taken. In case of such expulsion, any moneys paid the SOCIETY as endowment fees become forfeit to the SOCIETY and automatically become part of the research fund.

Article III

Dues

(1) Honorary and Ex officio Honorary Members shall be exempt from all fees and dues.

(2) The annual dues for Active and Associate Members shall be fixed by the Board of Trustees but shall not exceed ten dollars, six of which shall be a subscription to the *Journal of the American Ceramic Society*.

(3) Life Members shall pay a single endowment fee of $200.00, the interest earnings from which shall be used during the life of the member for current expenses. Upon the death of the member, the interest shall be used under the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(4) Corporation Members shall pay such annual dues as are fixed by the Board of Trustees but these shall not be less than twenty-five dollars, six dollars of which shall be a subscription to the *Journal of the American Ceramic Society*. The privileges of membership shall begin upon payment of the annual dues.

(5) Life Corporation Members shall pay a single endowment fee of $600.00, the interest earnings from which shall be used for current expenses for a period of twenty-five years after which time the interest shall be used under the direction of the Board of Trustees for ceramic research. The privileges of membership shall begin upon payment of this fee.

(6) Industrial Association Members shall pay such annual dues in monthly instalments or single payment as shall be agreed upon by the Association and the Board of Trustees, but such dues shall not be less than $480.00 annually.

Article IV

Officers

(1)The affairs of the SOCIETY shall be managed by a Board of Trustees, consisting of the President, Vice-President, Treasurer, the two most recent past Presidents, and one

trustee representative of each of the divisions. The President, Vice-President, and Treasurer shall be elected to serve one year. Each trustee shall be elected to serve three years.

(2) The President shall have general supervision of the affairs of the SOCIETY under the direction of the Board of Trustees of which he shall act as chairman and shall perform such other duties as pertain to his office.

(3) He shall countersign the checks drawn by the Treasurer when such drafts are known by him to be proper and duly authorized by the Board of Trustees.

(4) The Vice-President will preside at all meetings in the absence of the President. If the office of President should become vacant the Vice-President shall be vested with all the powers and required to perform all the duties of that office until a new President has been duly appointed by the Board of Trustees.

(5) A Secretary shall be appointed by the Board of Trustees for a term of not more than two years.

(6) The Secretary shall see that all moneys due the SOCIETY are collected and transferred to the custody of the Treasurer. He shall carefully scrutinize all expenditures and use his best endeavors to secure economy in the administration of the SOCIETY. He shall personally investigate and certify the accuracy of all bills or vouchers on which money is to be paid. He shall have charge of the books of accounts of the SOCIETY and shall furnish monthly to the Board of Trustees a statement of monthly balances. He shall present annually to the Board of Trustees a balance sheet of his books as of the 31st of December and shall furnish from time to time such other statements as may be required of him.

(7) The Secretary shall conduct the correspondence of the SOCIETY and keep full record of the same. He shall transmit promptly to the Board of Trustees for their consideration all communications not of routine nature. He shall cause to be published in the *Journal* the results of all balloting on the business of the SOCIETY unless otherwise ordered by the Board of Trustees. He shall perform all other duties which may from time to time be assigned to him by the Board of Trustees.

(8) The Secretary may be paid a salary to be determined by the Board of Trustees.

(9) The Secretary shall furnish a suitable bond for the satisfactory performance of his duties, which shall be held in the custody of the President.

(10) The Treasurer shall receive all moneys due the SOCIETY and deposit the same in the name of the SOCIETY in a national bank designated by the Treasurer and approved by the Board of Trustees. He shall invest all funds not needed for current disbursements, as shall be ordered by the Board of Trustees. He shall pay all bills by draft, when certified by the Secretary or as ordered by the Board of Trustees. He shall furnish a satisfactory bond for the proper performance of his duties, which shall be held in the custody of the President.

(11) All securities belonging to the SOCIETY shall be held in the custody of the Treasurer.

(12) The accounts of the Secretary and of the Treasurer shall be audited before each Annual Meeting by a certified public accountant or some other competent person designated by the Board of Trustees.

(13) A vacancy in any office shall be filled by appointment by the Board of Trustees but the new incumbent shall not thereby be rendered ineligible for reëlection to the same office at the next Annual Meeting. On the failure of any officer or any member of a committee to execute his duties within a reasonable time, the Board of Trustees, after duly warning such person, may declare the office vacant and appoint a new incumbent.

(14) A majority of the Board of Trustees shall constitute a quorum, but the Board of Trustees shall be permitted to carry on such business as it may desire by letter.

Article V

Nominations and Elections

(1) There shall be two nominating committees selected at each Annual Meeting. Such committees will each consist of seven members, one from each Division of the SOCIETY and each will prepare an independent ticket of nominations to be submitted to the SOCIETY for ballot. The members of the Nominating Committees will be selected as follows: At the final session of each Division two members of that Division will be elected to the Nominating Committee. These two will draw to determine which shall be on Committee No. 1 and which on Committee No. 2. The names and designations of these elected members of each Division will be immediately reported to the Secretary by the chairman or acting chairman of each Division.

Each Nominating Committee will be notified of its membership by the Secretary and each Committee will at once appoint its own chairman and proceed to the nomination of officers for the ensuing year.

There are no restrictions as to the make-up of the two tickets and the same or different names may appear upon the two slates.

(2) Nominations for President, Vice-President, and Treasurer. The Nominating Committees shall, by majority letter vote, select nominees for President, Vice-President, and Treasurer.

(3) Election. The names of all nominees for offices mentioned in the preceding paragraph of this article, provided their assent has been obtained before nomination, shall be placed upon a printed ballot in alphabetical order and shall be mailed to each voting member not in arrears at least twenty days before the Annual Meeting. The voting shall be confined to the names appearing on this ballot. The ballot shall be inclosed in an envelope on which there shall be no mark of identification other than the word "Ballot." The envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall endorse his name.

The envelopes and ballots shall be opened in the presence of three scrutineers appointed by the President, who will report the result of the election at the Annual Meeting.

A plurality of affirmative votes cast shall elect.

(4) Election of Trustees. Each division, by plurality letter vote of its major members, shall elect a trustee to serve for a period of three years according to the schedule provided in Section X of the By-Laws, the names of the Trustees thus chosen by the Division shall be certified to the Secretary of the SOCIETY not later than Dec. 31st of each year.

Article VI

Committees

(1) Except as otherwise provided the following Standing Committees shall be appointed annually by the Board of Trustees:

1. Rules
2. Publications
3. Membership
4. Standards
5. Sections and Divisions
6. Papers and Programs
7. Research
8. Geological Survey
9. Data
10. Ceramic Education
11. A Coördinating Service Council

Except as otherwise provided the chairman of each committee shall be appointed by the Board of Trustees.

(2) The Committee on Rules shall consist of the Chairmen of the Rules Committees of the Divisions having such committees. It shall receive all recommendations relating to changes of Constitution and By-Laws and shall report upon the same to the Secretary for transmission to the SOCIETY. It shall have power to propose changes in the Rules of the SOCIETY.

(3) The Committee on Publications shall consist of the Editor and four members. The duties of the Editor and Committee on Publications are defined under Article X on Publications.

(4) The Committee on Membership shall consist of the Chairmen of Membership Committees of the Divisions having such committees, and shall have power to appoint subcommittees. Its function shall be to undertake systematically the enlargement of the membership of the SOCIETY among those interested in the ceramic and allied industries.

(5) The Committee on Standards shall consist of a chairman and topic groups as follows:

(A) Group on Definitions, consisting of three members appointed by the Board of Trustees.

(B) Group on Raw Material Specifications, consisting of three members appointed by the Board of Trustees.

(C) Group on Standardization of Tests, consisting of one member selected by each Division.

(D) Group on Standardization of Products, consisting of one member selected by each Division.

(6) The Divisional Standardization Committees shall be selected by their respective Divisions. Their function shall be the preparation of tests and specifications for the materials and products of their respective branches of the ceramic industry. Each shall be responsible to its Division, but all reports, resolutions, or recommendations that are to be printed or generally distributed shall be approved by the Committee on Standards before publication.

(7) The function of the Committee on Standards shall be to prepare or have prepared tests and specifications for ceramic materials and products and to submit to the Board of Trustees written reports, resolutions, and recommendations relating thereto. The Committee may report at any regular meeting of the SOCIETY. For adoption, these reports, resolutions, and recommendations must be submitted in printed form to the members of the SOCIETY at least six months before a vote may be taken, during which time any amendments, changes, or corrections, suggested by any member may, with the approval of the Committee, be incorporated. The reports, resolutions, and recommendations as amended shall then be submitted by letter ballot to the voting members. A two-thirds vote shall be required for adoption and the polls shall close sixty days after distribution of the ballot.

(8) The Committee on Sections and Divisions shall consist of five members in addition to the Chairmen of the Divisions. Its duties shall be to promote the organization and welfare of Local Sections, Student Branches, and Divisions.

(9) The Committee on Papers and Programs shall consist of the Secretaries of the Divisions, the Secretary of the SOCIETY, and such other persons as the Board of Trustees may deem advisable. Its duties shall be to procure papers and discussions for the meetings and publications of the SOCIETY. The Committee may require an abstract of any paper submitted before placing it upon a program.

(10) The Committee on Research shall consist of one member selected by each

Division. Its duties shall be to organize and encourage scientific investigations pertaining to the ceramic and related industries, expecially those investigations which will stimulate the development of our national industries and resources. It shall be empowered to coöperate with similar committees of other scientific societies and with Government bureaus.

(11) The Committee on Geological Surveys will coöperate with national and state geological surveys and associations in planning laboratory and plant investigations instituted by them, and interpreting data. This Committee shall consist of a chairman and four members appointed by the Board.

(12) The Committee on Data shall arrange symposiums and prepare for publication monographs, bibliographies, statistics, etc. This Committee shall consist of one member selected by each Division.

(13) The Committee on Ceramic Education shall consist of one representative selected by each Division. This Committee shall make recommendations through the Board of Trustees for the betterment of ceramic education in institutions now established and for the encouragement of new departments of ceramics where the demand and facilities warrant.

(14) The Coördinating Service Council shall consist of the General Secretary, Ex officio Chairman, and the Chairmen of the Committees on Research, Standards, Geological Surveys, Data, and Ceramic Education. The Council shall have general supervision of the work of these Committees, for the purpose of coördinating other organizations on ceramic topics and problems.

Article VII

Divisions

(1) Groups to be known as Divisions of the SOCIETY and to be organized from members of the SOCIETY may be authorized by the Board of Trustees for stimulating the growth and development of the SOCIETY when such action shall seem wise and expedient. Only bona fide members of the SOCIETY are entitled to affiliate with and participate in the activities of such Divisions, but Divisions which, prior to August, 1920, have enrolled persons who are not members of the SOCIETY, may retain such persons as members of the Division. A member of the SOCIETY may enroll in any Division in which he is interested but for the purpose of nominating for Division representative on the Board of Trustees each member must declare one and only one Division as his major Division, and he shall be designated as a major member of that Division.

(2) The affairs of a Division shall be managed by a Chairman, a Secretary-Treasurer, and such other officers as the Division may deem necessary. The officers of the Division shall be elected annually by ballot at the last session of the Division held during the Annual Meeting of the SOCIETY and shall take office at the close of the meeting at which they are elected. All members of a Division are entitled to vote. The officers shall hold office for one year or until their successors are elected.

(3) Representatives of Divisions upon Committees of the SOCIETY shall be as indicated in Article VI.

(4) Divisions shall have power to make their own rules and by-laws except that they shall not adopt any rule or by-law which conflicts with the Constitution and By-Laws of the SOCIETY as a whole.

Article VIII

Local Sections

(1) Local Sections, each carrying some distinguishing title prefixed to the words "Section of the AMERICAN CERAMIC SOCIETY," may be authorized by the SOCIETY.

(2) The purposes of such Sections shall be to strengthen and extend the work of the SOCIETY, as defined in Article I of the Constitution, by more frequent meetings in local centers than are possible to the SOCIETY as a whole, and by bringing the benefits of the work to persons who would not otherwise be reached.

(3) Application for permission to form a Local Section must be in writing and signed by not less than ten members of the SOCIETY in good standing, residing in the general locality where the Section is to be formed, of whom one at least shall be an Active Member. To be considered at any given meeting an application must be filed with the Secretary at least thirty days prior to the date of the Meeting and notice that the application is pending must appear in the program of the Meeting. To be granted, the application must receive the affirmative vote of two-thirds of those present. In event of affirmative action the SOCIETY will issue a charter to the applicants, authorizing them to form a Section under the name proposed. Charters for Local Sections may be temporarily suspended by the Board of Trustees for cause, but no charter can be permanently rescinded except by vote of two-thirds of those present at a regular Meeting of the SOCIETY, after due publication in the program of the Meeting that the matter is pending.

(4) Local Sections shall have power to make their own rules and by-laws except that they shall not pass any rule or by-law which is in conflict with the rules of the SOCIETY.

(5) The officers of Local Sections shall be a Chairman, a Secretary, a Councillor, and such others as the Sections may prescribe. The duties of the Chairman and Secretary shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY. He shall be elected by the Local Section and it shall be his duty to advise the Section in all matters pertaining to its relations with the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Section. The names of the Chairman, Secretary, and Councillor of each Section shall appear in the roster of the SOCIETY.

Article IX

Student Branches

(1) Student Branches, each carrying some distinguishing title prefixed to the words "Student Branch of the AMERICAN CERAMIC SOCIETY," may be established in institutions in which regular courses of instruction in ceramics are maintained.

(2) The purpose of such Student Branches shall be to strengthen and extend the work of the SOCIETY, as defined in Section I of the Rules, by enlisting the interest and support of students in ceramics while still in school and by stimulating the spirit of ceramic research among them.

(3) Application to form a Student Branch in any institution must be in writing, signed by not less than five regularly enrolled students in good standing, and endorsed by two or more members of the SOCIETY. The application must be filed and acted upon as provided for Local Sections in Section IX, and may be suspended or revoked for cause in the same manner.

(4) Student Branches shall have power to make their own rules and by-laws, except that they shall not pass any rule or by-law in conflict with the rules of the SOCIETY.

(5) The officers of Student Branches shall be a Chairman, a Secretary, a Councillor, and such others as the Student Branch may prescribe. The Chairman and Secretary shall be elected by the Student Branch and their duties shall be such as usually pertain to those offices. The Councillor shall be an Active Member of the SOCIETY, appointed by the Board of Trustees to act in this capacity to the Student Branch. The duties of the Councillor shall be to advise the Student Branch in all matters pertaining to its relations to the SOCIETY and to make an annual report to the SOCIETY regarding the work and status of the Student Branch. The names of the Chairman, Secretary, and Councillor of each Student Branch shall appear in the roster of the SOCIETY.

Article X

Publications

(1) The Board of Trustees shall employ at suitable compensation an Editor of the *Journal of the American Ceramic Society* and an Advertising Manager, both of whom shall be nominated by the Committee on Publications to the Board of Trustees.

(2) The Committee on Publications shall have general supervision of the publications of the SOCIETY and of contracts and expenditures connected therewith, subject to the approval of the Board of Trustees.

(3) In the consideration of papers offered for presentation or publication those papers containing matter readily found elsewhere, those specially advocating personal interests, those carelessly prepared or controverting established facts, and those purely speculative or foreign to the purpose of the SOCIETY shall be rejected. The Committee on Publications shall determine which papers shall be printed. The Committee may return a paper to the writer for change or correction and may call to its aid one or more members of special experience relating to the subject treated, either to advise on the paper or to discuss it.

(4) All papers, discussions, and other writings which have been presented before the SOCIETY, its Divisions, or Sections, and all committee reports shall become the property of the SOCIETY. Their publication or other disposition shall be in the hands of the Committee on Publications.

Any papers, discussions, or writings not considered suitable for use in the publications of the SOCIETY by the Committee on Publications must be released or returned to the authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered within sixty days.

No reports prepared by a regularly appointed committee of the SOCIETY or of its Divisions or Sections shall be offered for publication elsewhere until the Committee on Publications shall have been given an opportunity of accepting such reports for publication by the SOCIETY.

(5) The Committee on Publications shall provide for the publication of a monthly periodical entitled the *Journal of the American Ceramic Society*, the subscription price of which shall be ten dollars to members and twelve dollars plus foreign postage to nonmembers.

(6) One copy of each issue of the paper bound edition of the *Journal* shall be sent prepaid to each member of the SOCIETY not in arrears. No member shall be furnished with more than one copy of each issue free for any single year. A member may be permitted to complete by purchase one file of the publications of the SOCIETY at less than the current commercial rate, the amount to be fixed by the Board of Trustees and to be called the member's rate.

(7) The Secretary shall have the custody of all publications of the SOCIETY, shall keep them safely stored and insured, and shall sell them to the public at prices which shall be fixed by the Board of Trustees. The Board of Trustees shall also, from time to time, fix the price of the volumes remaining unsold and shall have authority to refuse to sell the back volumes of the *Transactions* and *Journals* except in complete sets, at such time as the quantity remaining of any number becomes so small as in its judgment to warrant such action.

(8) The Editor shall request the author of each article appearing in the *Journal of the American Ceramic Society* to fill out and sign, within a definite time limit, a form, specifying the number of reprints of said article, if any, which he desires. This form shall contain a table from which can be computed the approximate cost at which any reprints will be furnished. In event that the expense of furnishing the desired number of reprints is large, the Board of Trustees may require the author to pay part or all of the

cost involved before the publication of the reprints is begun. On receipt of such signed order within the time limit set the Editor shall cause to have printed the desired number of copies. If the author makes no reply or replies after the time limit has expired then the SOCIETY will not be responsible for the publication of any reprints of the article in question except at the usual market price for the printing of new matter.

(9) No one shall have the right to demand the publication of an article independently of the discussion which accompanied it and no one having taken part in a discussion upon an article shall be entitled to order reprints of the discussion separately and apart from the article itself.

(10) The SOCIETY is not, as a body, responsible for the statement of facts or opinions expressed by individuals in its publications.

Article XI

Parliamentary Standard

Roberts' "Rules of Order" shall be the parliamentary standard on all points not covered by these rules.

Article XII

Amendments and Changes

Any proposed amendment to or change in this Constitution must be presented in writing at the Annual Meeting of the SOCIETY and, if approved by the Committee on Rules or by any ten Active Members, must be printed on a ballot and sent out not earlier than thirty nor later than sixty days after the adjournment of the Meeting at which the amendment or change was presented. If the said letter ballot shows an affirmative vote of not less than two-thirds of the total vote cast within thirty (30) days after the date of mailing, then the same shall be declared carried and shall at once become effective.

Article XIII

By-Laws

The SOCIETY shall make such By-Laws not in conflict with this Constitution as may be necessary for the proper government of the SOCIETY. Such By-Laws shall become operative when approved by the Board of Trustees and confirmed by a two-thirds affirmative vote of the members voting at any annual meeting.

Section I

Meetings

(1) The Annual Meeting shall take place on the first Monday in February, or as soon thereafter as can be arranged, at such place as the Board of Trustees may decide, at which time reports shall be made by the Board of Trustees, Treasurer, and scrutineers of election, and the accounts of the Treasurer shall be audited by a committee of three appointed by the President. Fifty Active Members shall constitute a quorum at the Annual Meeting and a majority shall rule unless otherwise specified.

(2) Other meetings may be held at such times and places during the year as the Board of Trustees may decide, but at least twenty days' notice shall be given of any meeting.

(3) The President shall appoint at the Annual Meeting a committee of five, to be known as the Summer Meeting Committee, whose duty it shall be to arrange for a summer excursion meeting at some suitable point. They shall then select a local com-

mittee which shall have charge of the details of the meeting. The expenses of the Summer Meeting Committee in arranging the program of visits and for printing, rooms, and facilities for meetings shall be borne by the SOCIETY.

Section II

(1) At the Annual Meeting of the SOCIETY, the order of business shall be as follows:

1. President's Address
2. Reading of Minutes of Last Meeting
3. Committee Reports
4. Reports of the Board of Trustees and Treasurer
5. Old Business
6. New Business
7. Reading of Papers
8. Announcement of Election of Officers, Honorary and Active Members
9. Installation of Officers
10. Appointment of Committees
11. Adjournment

Section III

Only Active Members shall be eligible to election as officers.

Section IV

Any members in arrears for over one year may be suspended from membership by the Board of Trustees until such arrears are paid. Active Members in arrears are not eligible to vote. The annual dues are payable on January first.

Section V

The Secretary of each Division, Local Section, and Student Branch shall report to the Secretary of the SOCIETY the names of its officers and Standing Committee Chairmen within three weeks of their election or appointment and shall also furnish the Secretary with a complete list of its membership on April 1 of each year.

Section VI

(1) Any person interested in the ceramic and allied industries is eligible to membership in a Local Section.

(2) Local Sections shall have power to fix their own dues or assessments, such dues or assessments being in addition to and independent of the regular dues and assessments of the SOCIETY upon its members. No Section shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

Section VII

(1) Membership in a Student Branch shall be limited to the instructional force and regularly enrolled students of schools in which branches are located, subject to the rules of the school concerned governing outside activities of students.

(2) Student Branches shall have power to fix their own dues and assessments and as such shall pay no dues to the SOCIETY. No Student Branch shall have authority to incur debt in the name of the SOCIETY or for which the SOCIETY may become liable.

(3) Members of a Student Branch shall pay no dues to the SOCIETY but, upon depositing a certificate of good standing from their Secretary, may purchase from the SOCIETY its publications at the same rate as Associate Members of the SOCIETY. This

privilege shall cease when the student's connection with the school ceases, but members of a Student Branch, upon leaving school, may at once become Associate Members of the SOCIETY by depositing their certificates, making proper application, and paying the regular dues.

Section VIII

(1) The Board of Trustees shall appoint such special committees as may seem necessary for the proper conduct of the affairs of this SOCIETY.

(2) All special coöperative committees shall be appointed only on nomination of the Coördinating Service Council.

Section IX

To provide for rotation of the nominations of Trustees as representatives of the Divisions, as provided in Articles IV and V of the Constitution, some shall be nominated in 1923 to serve portions of the three-year terms as follows:

Terra Cotta to serve three years
Enamel to serve one year
Refractories to serve one year
White Wares to serve two years
Art to serve one year
Heavy Clay Products to serve three years
Glass to serve two years

Section X

The Board of Trustees shall have power to make any rules not inconsistent with the Constitution and By-Laws for the conduct of its business.

NOTES FROM THE LOCAL SECTIONS

Pittsburgh Section

The March meeting of the Pittsburgh Section was held in the Fellow's Room of the Mellon Institute on Tuesday evening, March 12. Following a moving picture presentation of the grinding wheel industry, Ross C. Purdy, General Secretary, addressed the section on the same subject.

The April meeting is scheduled to be held on Thursday, April 18, at the U. S. Bureau of Mines, 4900 Forbes St., and will be in conjunction with the local section of the American Chemical Society. M. C. Booze will be the speaker of the evening.

It was voted to hold the June meeting in Beaver Falls.

The following members and friends were present at the April meeting: J. Ross Buchanan, Mayer China Co.; John Topping, Carnegie Steel Co.; Richard E. Reif, and W. Keith McAfee, Universal Sanitary Mfg. Co.; E. W. Tillotson, R. F. Ferguson, S. M. Swain, Jack Waggoner, A. C. Hughes, V. Cartwright, and B. A. Rice, all of Mellon Institute; Drury D. Turner, C. C. Schott, and R. C. Boyd of Standard Sanitary Mfg. Co.; A. W. Kimes, *National Glass Budget;* K. G. Kutchka, Pittsburgh Plate Glass Co.; L. A. Smith, Jones & Laughlin Steel Co.; P. A. Smith, The A. F. Smith Co.; J. S. McDowell, Harbison-Walker Refractories Co.; F. B. Sauereisen, Technical Products Co.; F. J. Williams and A. Silverman, University of Pittsburgh; Geo. A. Wells, Ford City, Pa.; Geo. E. Crawford, Eljer Co.; R. O. Anderson, Norton Co.; C. A. Carlson, Worcester, Mass.; R. A. Snyder and H. M. Kraner, Westinghouse Co.

OBITUARY

Thomas A. Shegog

Thomas Alexander Shegog, a member of the AMERICAN CERAMIC SOCIETY since 1922, died at East Liverpool, Ohio, on January 23, 1929. His death was very sudden, taking place after an illness of only a day. Burial was in Riverview Cemetery at East Liverpool, in the presence of a number of pottery executives and fellow ceramists.

Mr. Shegog was born in Dublin, Ireland, in 1864 and received his early education in that city. He studied as a medical student at Trinity College, Dublin, for three years but abandoned the study of medicine for that of chemistry. He served his time as a practical chemist and received his diploma at the Royal College of Science, Dublin, as a Fellow of the Institute of Chemistry. He also served several years as a professor. Later he was analytical chemist and lecturer to the County Council at Newport, England. He then became chemist and ceramic expert at Messrs. Tuyford's, Ltd., sanitary potters, at Stoke-on-Trent. He held this position until his departure for the United States. In this country he again became associated with ceramic work, both in works practice and in a consulting capacity. Some years ago he was chemist for the Sebring Pottery Co., Sebring, Ohio, and his last position was with the Tennessee Mineral Products Co.

Being an earnest student of chemical science Mr. Shegog found his greatest pleasure in adding to his knowledge. His was of a reserved nature, somewhat difficult of approach, but ever ready to share his information with anyone seeking his assistance. He was a quiet man of genial and kindly disposition. His interest in the SOCIETY was deep and constant. At the same time he was active in the founding of the American Institute of Chemistry.

Mr. Shegog had a family of five daughters and one son and had lost his wife some years ago.

ITINERARY FOR BRITISH CERAMISTS IN AMERICA

Monday, April 29

(1) Party to be welcomed by a reception committee on board ship and accompanied to shore

(2) Proceed by auto to Hotel Pennsylvania. After luncheon motor about city
Optional trips to Metropolitan Museum; N. Y. Architectural Terra Cotta Co. Refractory Plant and Hudson River Brick Plant

(3) Banquet at Hotel Pennsylvania

Tuesday, April 30

8:30 A.M. Leave by bus via Holland Tunnel, for Perth Amboy, arriving at 10:00 A.M.
Optional trips: (*a*) Federal Terra Cotta Co., (*b*) Carborundum Co. (Refractories), (*c*) General Ceramics Co. (Refractories), (*d*) Ford and General Ceramics Co. (Porcelain), (*e*) Rossman Tile and others

7:00 P.M. Banquet at Hotel Woodrow Wilson, New Brunswick, N. J.

Wednesday, May 1

8:30 A.M. Leave for Metuchen by auto bus. Sanitary Plant, General Ceramics Co.
11:00 Leave for Princeton by auto bus
1:00 P.M. Lunch, Princeton Inn
3:30 Leave by bus for Trenton
7:00 Banquet at Trenton Country Club

Thursday, May 2

9:00 A.M. Trenton Potteries, Thos. Maddock Sons Co., Scammell China Co., Robertson Art Tile Co., Lenox, Inc., Mitchell-Bissell Co.
4:00 P.M. Tea, Hotel Stacey-Trent
5:30 P.M. Informal dinner; entraining for Philadelphia
8:00 P.M. Banquet, Bellevue-Stratford
1:00 A.M. Refractories take night train for Baltimore arriving 3:30, detraining by 7:00 A.M.

Friday, May 3

9:00 A.M. White Wares and Building groups tour Philadelphia, including Art Gallery, Conkling-Armstrong, Art Potteries, Abrasive and Precision
6:30 P.M. Leave for Washington, arriving 9:50 P.M. Refractories tour Baltimore during day, moving on to Washington in evening

Saturday, May 4

9:00 A.M. Bureau of Standards and Geophysical Laboratories. Tomb of unknown soldier
1:00 P.M. Reception at White House and tour of city
6:30 Refractories leave for St. Louis. White Wares remain over night

Sunday, May 5

(1) White Wares and Building group sightseeing and move on to Baltimore
(2) Refractories arrive St. Louis 5:10 P.M. Entrain 7:30 P.M.; arrive Mexico, Mo., 10:09. P.M.

Monday, May 6

(1) White Wares and Building Materials groups visit Locke Insulation Plant and Standard Sanitary Mfg. Co. in morning
(2) Refractories visit A. P. Green Fire Brick Co., and leave Mexico 6:00 P.M.; arrive St. Louis 9:00 P.M.
11:35 White Wares entrain for Beaver Falls, Pa.

Tuesday, May 7

(1) Refractories visit plants in St. Louis, entraining for Pittsburgh
(2) White Wares and Building Materials in Beaver Falls. Lunch at Hotel General Broadhead. Leave for Pittsburgh 5:27, arriving 6:15 P.M.

Wednesday, May 8

A.M. White Wares and Building Materials group visit Mellon Institute, U. S. Bureau of Mines, steel plants
7:05 P.M. Refractories arrive Pittsburgh. Banquet Hotel Schenley

Thursday, May 9

A.M. Refractories at Mellon Institute and Harbison-Walker at Hays Station and Kier at Salina
8:05 P.M. White Wares to East Liverpool by train; arrive 9:45 A.M.
8:05 P.M. Building Materials leave by train for Alliance, arriving 10:33 A.M.

Friday, May 10

(1) Refractories leave Pittsburgh by bus for Central Pennsylvania
(2) White Wares leave by bus for Lisbon, Alliance, Sebring, Canton
(3) Building Materials in Canton leaving by bus for Malvern, over night in New Philadelphia

Saturday, May 11

(1) Refractories visit Harbison-Walker Refractories Co. and Mt. Union Refractories Co., Mt. Union, Pa., and Penn State College
(2) White Wares motor from Canton to Zanesville via New Philadelphia and Cambridge, arriving Zanesville in evening
(3) Building Materials motor to Zanesville, visiting plants in Midvale, Port Washington, Newcomerstown and Uhrichsville
(4) Banquet in Zanesville

Sunday, May 12

(1) Refractories motor through mountains about Clearfield
(2) White Wares and Building Materials motor about Zanesville to Crooksville and Roseville, seeing the Roseville plant of the O. S. U. Engineering Experiment Station

Monday, May 13

(1) Refractories see Harbison-Walker plants in Clearfield and Woodland
(2) White Wares in Zanesville
(3) Building Materials by motor to plants in Zanesville, Logan, etc., on to Columbus

Tuesday, May 14

(1) Refractories in Clearfield and Curwensville district, leaving DuBois for Buffalo 1:07 P.M., arriving 5:35
(2) White Wares complete Zanesville tours and motor bus to Columbus
(3) Building Materials completing plant tours in Ohio
(3a) 3:30 P.M. Tea at offices of AMERICAN CERAMIC SOCIETY
(4) Banquet, Faculty Club, O. S. U.
(5) White Wares and Building Materials entrain for Buffalo 10:45 P.M., arriving 6:50 A.M.

Wednesday, May 15

(1) Entire party motor to Toronto seeing plants enroute
(2) Banquet in evening with the Canadian Clay Products Association; over night at King Edward Hotel

Thursday, May 16

(1) White Wares, Buffalo Pottery in forenoon, leave for Syracuse at 1:00 P.M.
(2) Refractories guests of Exolon Co., electric refractories, and Buffalo Pottery Co., leaving for New York in evening
(3) Building Materials see electric kiln at Buffalo Pottery and brick plants nearby, leaving for New York City in evening

Friday, May 17

(1) White Wares in Syracuse
(2) Refractories and Building Materials in New York City

Saturday, May 18

Entire party in New York City, sailing at noon.

NOTES AND NEWS

CERAMIC EXPOSITION AT RUTGERS UNIVERSITY

The Ceramics Club of Rutgers University held a Ceramic Exposition March 8 to 16 in the Ceramics Building, New Brunswick, N. J. The Exposition included exhibits of ceramic products and processes of manufacture. Interesting demonstrations of these processes were arranged by the students in the ceramic department. Exhibits of the

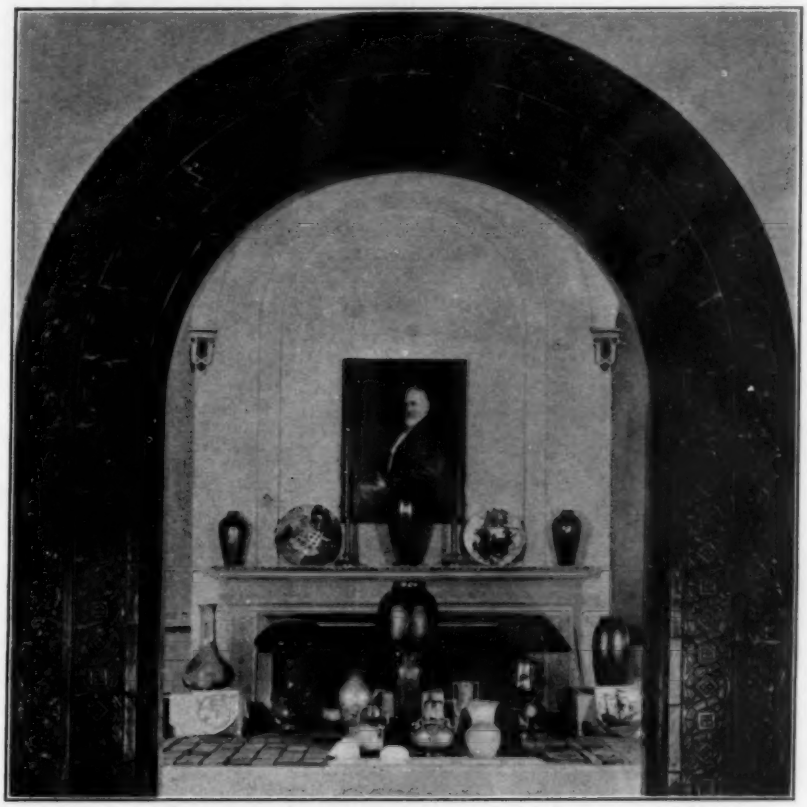

FIG. 1.—A view of the assembly room from the corridor.

finest china, pottery, glass, and other ceramic products were on display. The exposition was made possible through the courtesy and coöperation of the manufacturers who are striving to show the public the variety and high degree of excellency of ceramic products manufactured in New Jersey. The Exposition offered an opportunity for the public to become acquainted with the type and character of work done by the students in ceramics.

The 76 exhibits were quite varied in character, covering the whole range of ceramic products from fine tableware and art pottery to common brick and fireproofing. They

FIG. 2.—Art exhibit in the assembly room.

FIG. 3.—Another view of assembly room.

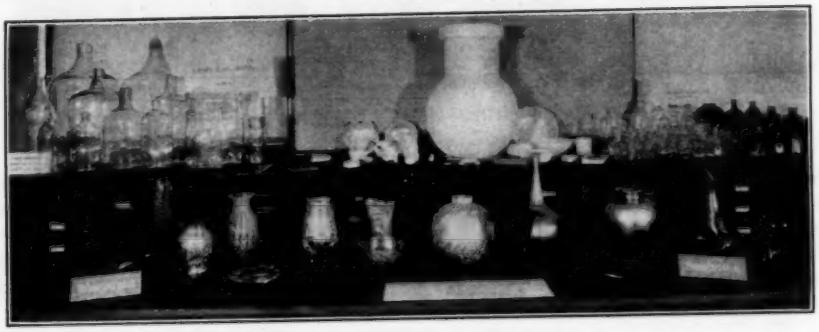

FIG. 4.—Glassware exhibit.

were arranged in three groups: (1) pottery, terra cotta, floor and wall tile, electrical porcelains, tableware, etc., were on display in the main assembly room; (2) refractories and heavy clay products were exhibited in one of the large class rooms; (3) glass and raw

FIG. 5.—Refractories exhibit.

FIG. 6.—Demonstration by students.

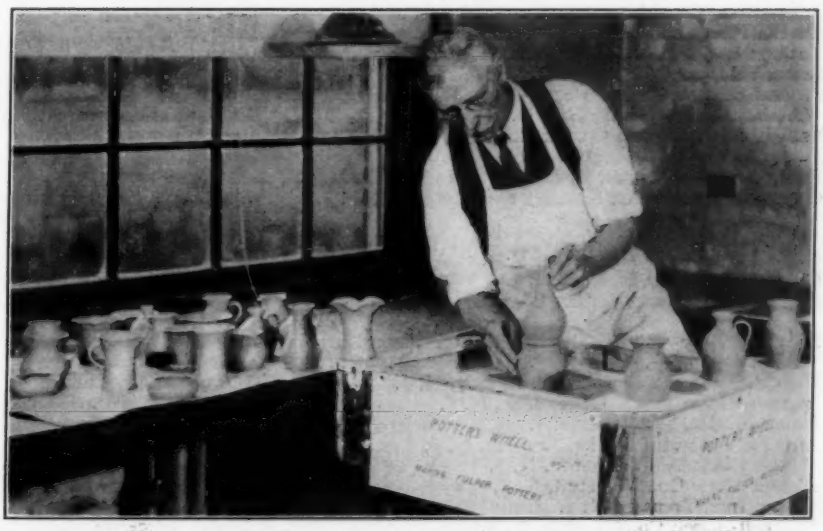

FIG. 7.—Throwing pottery.

materials were on display in another classroom. Scientific glassware, enamels, etc., were shown in the chemical laboratory.

At first the exposition was planned for only two days, March 8 and 9. Attendance on these days was over 1200 and in view of the interest shown it was decided to hold the

exhibits over for another week. The register shows that visitors came from eight states and 63 cities and towns in New Jersey.

In connection with the exhibits of ceramic products manufactured in New Jersey, there were demonstrations in the laboratories by students and others of the processes involved in the manufacture of the various products. These included glass-melting, firing of pottery, brickmaking, throwing, casting, and pressing of pottery, enameling, glass-blowing, use of the microscope, etc.

Many requests have come from manufacturers to repeat the Exposition again next year. The whole affair has involved much work on the part of the staff and students in the department and especial credit is due Prof. George H. Brown, head of the department.

List of Exhibitors

American Enameled Brick & Tile Co., South River, N. J.	Enameled brick
Anness Hollow Tile & Clay Co., Woodbridge, N. J.	Hollow tile and clays
Antimony Products Co., New Brunswick, N. J.	Antimony products
Atlantic Terra Cotta Co., Perth Amboy, N. J.	Architectural terra cotta
Consolidated Feldspar Co., Trenton, N. J.	Feldspar
Carborundum Co., Perth Amboy, N. J.	Carborundum refractories
Cook Pottery Co., Trenton, N. J.	Electrical porcelain and plumbing fixtures
Crossman Co., South Amboy, N. J.	Clays
Cook China Co., Trenton, N. J.	Tableware and novelties
Crescent Tile Co., Trenton, N. J.	Floor tile
Crossley Machine Co., Trenton, N. J.	Ceramic machinery
Hampton Cutter, Woodbridge, N. J.	Clays
Jos. Dixon Crucible Co., Jersey City, N. J.	Graphite and clay crucibles
Edgar Bros. Co., Metuchen, N. J.	Clays
Eureka Flint and Spar Co., Trenton, N. J.	Feldspars, flints
Enterprise White Clay Co. (Office, Philadelphia, Pa.)	Clays
Erwin Feldspar Co., Trenton, N. J.	Feldspar
Federal Seaboard Terra Cotta Corp., Woodbridge, Perth Amboy, and South Amboy, N. J.	Architectural terra cotta
Frenchtown Porcelain Co., Frenchtown, N. J.	Porcelain specialties
Fulper Pottery, Flemington, N. J.	Art pottery
Fords Porcelain Works, Perth Amboy and Fords, N. J.	Porcelain sanitary ware
General Ceramics Co., Keasbey and Metuchen, N. J.	Chemical stoneware and magnesia porcelain specialties
Globe Porcelain Co., Trenton, N. J.	Plumbing fixtures
Golding Sons Co., Trenton, N. J.	Flint and feldspar
Gayner Glass Works, Salem, N. J.	Large bottles and containers
Harrison Bulb Works, General Electric Co., Harrison, N. J.	Glass bulbs
Otto E. Hansen & Sons, Perth Amboy, N. J.	Electric and gas logs
Ingram-Richardson Co., Bayonne, N. J.	Sheet steel enameled ware
Isolantite Co., Belleville, N. J.	Porcelain specialties
Imperial Porcelain Works, Trenton, N. J.	High tension porcelains
Illinois Glass Co., Bridgeton, N. J.	Glass bottles
Kimble Glass Co., Vineland, N. J.	Scientific glassware
Lenox, Inc., Trenton, N. J.	Tableware, Belleek
Mitchell-Bissell Co., Trenton, N. J.	Textile porcelain, plumbing fixtures
Mueller Mosaic Co., Trenton, N. J.	Faience, floor and wall tile
Thos. Maddock's Sons Co., Trenton, N. J.	Vitreous sanitary ware
Mercer Pottery, Trenton, N. J.	Tableware
Monument Pottery Co., Trenton, N. J.	Porcelain (all clay) sanitary ware
Mosaic Tile Co., Matawan, N. J.	Floor and wall tile

Matawan Tile Co., Matawan, N. J.	Floor tile
Mountainside Art Pottery, Mountainside, N. J.	Art pottery
Metal & Thermit Corp., Carteret, N. J.	Ceramic materials
Mutton Hollow Fire Brick Co., Woodbridge, N. J.	Refractories and furnaces
John A. Manley, New Brunswick, N. J.	Museum collection, old pottery and clay products
New Jersey Decalcomania, Trenton, N. J.	Delc decalcomanias
New Jersey Tile Co., Trenton, N. J.	Floor tile
National Fireproofing Co., Perth Amboy, N. J.	Fireproofing and brick
Progressive Art Tile Co., Matawan, N. J.	Art tile
C. Pardee Tile Works, Perth Amboy, N. J.	Floor and wall tile
Paragon Brick Co., South River, N. J.	Sand lime brick
Perlee, Inc., Trenton, N. J.	Tableware, Belleek
Porcelain Enamel and Mfg. Co., Baltimore, Md.	Enamels for cast iron and sheet steel
Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.	Ceramic colors and material
Rossman Corp., Perth Amboy, N. J.	Floor tile
Rossman Corp., Old Bridge, N. J.	Wall tile
Robertson Art Tile Co., Trenton, N. J.	Floor and wall tile
Star Porcelain Co., Trenton, N. J.	Electrical porcelain and specialties
Superior Fire Linings Co., Trenton, N. J.	Fireclay refractories
Seaboard Refractories Co., Perth Amboy, N. J.	Clay and special refractories
Sayre and Fisher, Sayreville, N. J.	Common, face, enameled and fire brick
Star Clay Products Co., Berkeley Heights, N. J.	Flower pots
Scammell China Co., Trenton, N. J.	Hotel china
Sneyd Enameled Brick Co.	Enameled and fireclay brick
Salem Glass Works, Salem, N. J.	Glass bottles
Trenton Potteries Co., Trenton, N. J.	Vitreous sanitary ware
Trumbull Electric Co., Trenton, N. J.	Electrical porcelain and plumbing fixtures
Tavern Rock Sand Co., Millville, N. J.	N. J. glass sand
Thermal Syndicate, 58 Schenectady Ave., Brooklyn	Fused silica ware
United Clay Mines Corp., Trenton, N. J.	Clays
M. D. Valentine & Bro. Co., Woodbridge, N. J.	Fireclay refractories
Vineland Flint Glass Co., Vineland, N. J.	Art glassware
T. C. Wheaton Co., Millville, N. J.	Colored glassware for cosmetics, etc.
Whitall-Tatum Co., Millville, N. J.	Glass bottles
Westinghouse Lamp Co., Bloomfield, N. J.	Parts for incandescent lamps
Willette Corp., New Brunswick, N. J.	Plumbing fixtures
Woodbridge Ceramic Corp., Woodbridge, N. J.	Porcelain (all clay) sanitary ware

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REFRACTORIES ADVISORY BOARD FOR PENN STATE

Ten prominent men in the refractories industry from Pennsylvania have been appointed to form an advisory board for the School of Mines and Metallurgy of Pennsylvania State College, according to an announcement today by Edward Steidle, Dean of the School of Mines and Metallurgy at Penn State.

The Board will assist in working out various problems of the Department of Ceramics so that the College may better serve the refractories industries of the state. The program of the College embraces: (1) fundamental education and extension courses that fit the requirements of the industries, and (2) applied research and investigation that will

conserve and better utilize the natural resources and help make for better efficiency in the industries.

The following are members of the Board: C. A. Waters, Secretary, Pennsylvania State Department of Labor and Industry; C. W. Bickford, General Manager, Osceola Silica & Fire Brick Co., Osceola Mills; R. P. M. Davis, President of the U. S. Refractories Co., Mount Union; George G. Diack, General Manager, Queen's Run Refractories Co., Inc., Lock Haven; J. H. France, President of J. H. France Refractories Co., Philipsburg; S. M. Kier, President of the Kier Fire Brick Co., Pittsburgh; W. B. Coullie, Assistant General Sales Manager, Harbison-Walker Refractories Co., Pittsburgh; Eugene McKelvey, Vice-President of the General Refractories Co., Philadelphia; J. M. McKinley, Vice-President & General Manager, Crescent Refractories Co., Curwensville; and Ralph L. Swank, President of Hiram Swank Sons, Johnstown.

DEVELOPMENT OF THE CERAMIC ENGINEERING PROFESSION

ARTHUR S. WATTS[1]

On February 5, 1929, a reunion of ceramic graduates and ex-students of Ohio State University was held at Chicago, Illinois, in connection with the Annual Meeting of the AMERICAN CERAMIC SOCIETY. One hundred and two were present. At a banquet in the evening, 78 were present, including 73 graduates and 5 ex-students. As this represents more than 25 per cent of the graduates from this department, it furnished a basis for compilation of some very important data on the ceramic engineering profession, and this was obtained by questionnaires. The data obtained is as follows:

Distribution by classes: Prior to 1905, 10; 1906 to 1910, 7; 1911 to 1915, 9; 1916 to 1920, 19; 1921 to 1925, 19; 1926 to date, 14.

Distribution by industries: Metal enamels 2.5%; glass 2.5%; heavy clay products 10%; refractories 17%; terra cotta 17%; whiteware 28%; research 14%; teachers 9%.

Data on initial salaries of ceramic graduates: Average 1899 to 1905, $640; 1905 to 1910, $960; 1911 to 1915, $1060; 1916 to 1920, $1410; 1921 to 1925, $1690; 1926 to date, $1810.

Data on present salaries of ceramic graduates: Average 1899 to 1905, $7400; 1906 to 1910, $8000; 1911 to 1915, $6900; 1916 to 1920, $5200; 1921 to 1925, $4950; 1925 to date, $2880.

The average salary of all men out 5 years or more is $6086.00.

This value is interesting when compared with similar data obtained at a meeting about two years ago of 40 ceramic graduates from Ohio State University which indicated an average salary for men out 5 years or more of $5691.00.

These men are keeping in touch with research and development in their profession, and the salaries paid them are distinctly higher than those of the graduate who has been indifferent to progress since graduation. The ceramic engineer who is not in this progressive group should ask himself whether he can afford to continue this indifference.

Another very important analysis obtained through a questionnaire compiled at this reunion concerned the nature of ceramic instruction required to best equip the graduate. This disclosed the fact that 61% of the graduates present are not now in the field of ceramics which they expected to follow when they graduated from the University. Of the 78 men present at the reunion, 6 have worked in 5 or more different branches of ceramic industry since graduation, 5 men have worked in 4 different branches of ceramics, 12 have worked in 3 different branches of ceramics, 13 have worked in 2 different branches of ceramics since graduation.

To allow a student to specialize in his undergraduate courses so limits his training that he is in a majority of cases not equipped for the work that he has, by the general training given in the past, been able to succeed in, if the salary average may be considered an indication of success.

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[1] Head of Dept. of Ceramic Engineering, Ohio State University. Written for the *Ohio State Engineer*, March, 1929.

The present and proposed curriculum of the ceramic engineering department requires that the ceramic graduate shall have a working knowledge of at least three branches of ceramics and that he shall have fundamental knowledge of three additional branches. Fundamentals in general ceramics have been stressed in the past and will be in the future.

Analysis of the fact that 46% of the men interviewed have worked in two or more fields does not signify that they failed to make good in the field originally chosen, but in many cases it indicates that the change was due to special inducements offered in some other field of ceramics. The market for men with ability and with broad training in ceramic engineering has steadily increased but the demand for men who are barely able to make passing grades is less each year. The fact that extra-curricular activities have caused a man to fail in his major purpose in college, is taken by most manufacturers to indicate a tendency on the part of the student to neglect his major duties for the social and recreational side of life. This attitude on the part of employers forces the ceramic engineering department to be more severe than ever in the granting of credit for ceramic courses and to demand equal severity from other departments which participate in the education of the future ceramic engineer. Only in this way can we hope to produce the quality of product demanded by the industries which we are endeavoring to serve.

THE ENGINEERING INDEX SERVICE

The Journal of the American Ceramic Society is fully indexed as soon as published, in a set of cards, which thus brings ready to your hand any article on any subject in this *Journal* or in any one of 1700 other journals in all languages. This Engineering Index Service, instituted in January, 1928, is to be found in the Public Libraries of Newark, Cleveland, Bridgeport, Baltimore and the John Crerar Library, Chicago.

JOSIAH WEDGWOOD BICENTENARY[1]

The bicentenary of the birth of Josiah Wedgwood, the famous 18th century master potter, will be celebrated next year. He was born at Burslem, Staffordshire, in 1730. He is rightly acknowledged as the "father" of the Staffordshire pottery industry, and a worthy monument to him is the world-famous works of Messrs. Josiah Wedgwood and Son, Ltd., Etruria, which he built in 1769 and which has ever since—through five generations—had a member of the Wedgwood family as the controlling head.

On the death of his father, he became apprenticed to the pottery trade. When quite young, he commenced business on his own account and after a wonderful career, in which he developed the artistic side of the industry, he died in 1795 and was buried in Stoke Parish Church.

Preliminary arrangements are already being made for a worthy celebration of the event in his native district, and it is expected that those connected with the pottery industry in all parts of the world will join in fittingly memorializing the birth and lifework of one whose equal has never been seen.

The first step has been taken by the Ceramic Society, which has decided to publish a commemorative volume. Making the announcement, J. W. Mellor, secretary of the Ceramic Society, has sent out the following circular to the members:

The Council of the Ceramic Society has decided to hold a celebration of the bicentenary of Josiah Wedgwood in 1930, at some date to be fixed later. As part of that celebration a commemoration volume will be published.

This volume will contain a paper by the original Josiah (selected from his notebooks), possibly a brief commentary on Josiah, the prize essays on his technical work, and papers sent in by members of the society. We are giving good notice so that members will have time to prepare special papers. The papers can take any form the members think fitting. In some cases a concise review of their own published work, with modifications and additions necessitated by maturer experience, would be suitable. Do not be afraid of short notes, for the 2030 comment might be: "The old boy knew what he wanted to say and said it quickly, without wasting paper."

[1] Reprinted from *Pottery and Glass Record*, February, 1929.

The Council therefore invites papers from members for the Wedgwood Bicentenary Commemoration Volume, in the confident hope that the volume will be worthy of the occasion.

There will probably also be a full "gathering of the clans" at Stoke-on-Trent, where all the sections will "celebrate."

The Council of the Ceramic Society will offer two prizes for the best papers or essays on the "Contributions of Josiah Wedgwood to the Technical Side of the Pottery Industry." The conditions are as follows:

(1) The competition is open to nonmembers as well as members of the society.
(2) Each competitor's paper is to extend to anything less than 20,000 words.
(3) The first prize will be 35 guineas and the second prize 15 guineas.
(4) The successful papers are to be the property of the Ceramic Society, and it is intended to publish them in the Bicentenary Commemoration Volume.
(5) Messrs. Josiah Wedgwood and Sons, Ltd., have kindly placed their Museum at the disposal of competitors. The Curator (Mr. Cook) will be pleased to arrange hours for visits where the first Josiah Wedgwood's notebooks and trials can be inspected.
(6) The society reserves to itself the right of withholding one or both prizes if the papers are not up to the required standard.
(7) All papers must be sent to the Secretary of the society not later than March 31, 1930.

GRADUATE FELLOWSHIPS IN ENGINEERING

Ohio State University

By arrangement of the Graduate School, the College of Engineering, the Engineering Experiment Station, and the Columbus Branch, U. S. Bureau of Standards, and through the courtesy of a number of donors, several fellowships for graduate study in engineering are available each year at the Ohio State University.

These fellowships are awarded to holders of the bachelor's and master's degrees. The fellows are registered in the Graduate School, are exempt from all fees except matriculation and diploma, and are required to do no teaching. The research projects (including thesis) constitute a large portion of the required work, and are supplemented by approved graduate courses. Ordinarily one year's residence is sufficient to enable the fellow to obtain the master's degree. The holder of a fellowship may apply for its renewal at the end of each year, and fellows are encouraged to work for the doctorate. The stipend for the school year, nine months, is $750.

Applications for Stillman W. Robinson and Nathaniel Wright Lord Fellowships were filed by March 1, 1929.

In coöperation with the Columbus Branch, U. S. Bureau of Standards, the Engineering Experiment Station offers three research fellowships in ceramics open to graduates who have had sufficient training in ceramics, metallurgy, or chemistry, to carry on the particular research assigned. Applications should be filed by May 15 with the Director, Ohio Engineering Experiment Station, or with the Superintendent, Columbus Branch, Bureau of Standards. These fellowships can be awarded only to citizens of the United States.

The Engineering Experiment Station coöperates with industry by making its facilities available for research work of graduate fellows supported by associations or companies. The number of these fellowships varies from year to year, and any field of engineering may be represented. The establishment of a fellowship may be contingent upon the availability of a suitable man to undertake the work. Accordingly, applications giving full qualifications will be welcomed at any time during the year. Address the Director, Engineering Experiment Station.

The possible field for industrial fellowships is as broad as industry. An idea of the branches covered may be obtained from the following list of fellowships maintained in recent years.

Cambridge Sanitary Ware Co. (Ceramic)
National Lime Association (Chemical engineering)
Federal Glass Co.—Findlay Clay Products Co. (Glass tank refractories)

American Institute of Steel Construction (Structural)
Electrical Porcelain Manufacturing Association (Ceramic)
Calcium Chloride Publicity Committee (Civil engineering study of curing of concrete)
Aluminum Company of America (Ceramic engineering)

Additional information and application blanks may be obtained for the Robinson and Lord Fellowships from the Dean, Graduate School, Ohio State University, Columbus, Ohio; for the ceramic and industrial fellowships from the Director, Engineering Experiment Station, Ohio State University, Columbus, Ohio.

Nonmetallics at University of Washington

The College of Mines of the University of Washington offers five fellowships for research in Coal and Nonmetallics in coöperative work with the U. S. Bureau of Mines. The value of each fellowship to the holder is $720, for 12 months beginning July 1; fellowship holders pay tuition and laboratory fees, but are reimbursed for the amounts so expended.

The fellowships are open to graduates of universities and technical colleges who are qualified to undertake research investigation. Ordinarily the appointees register as graduate students and, if properly prepared, become candidates for the degree of Master of Science in mining or metallurgy or ceramics; otherwise they may register for a bachelor's degree in one of these curricula.

The purpose of these fellowships is to undertake the solution of various problems being studied by the U. S. Bureau of Mines that are of especial importance to the State of Washington, the Pacific Northwest, and Alaska. The investigations consist principally of laboratory work directed largely by the Bureau's technologists. The work is performed in the building known as Mines Laboratory, which has recently been doubled in size and fully equipped with the newest forms of machinery and apparatus. For the year 1929–30 the following subjects have been selected for investigation:

(1) *Coal:* (*a*) utilization: studies of the character of coals in relation to their utilization; coals of all ranks from lignite to anthracite occur in the State of Washington; (*b*) beneficiation: studies of the mechanism of coal-cleaning methods and the determination of performance; the greater portion of the coal output of the state is cleaned mechanically.

(2) *Nonmetallics:* (*a*) purification: washing of kaolins and ochres; (*b*) problems in drying certain nonmetallics; (*c*) preparation of feldspars.

Information concerning applications for these fellowships may be obtained from Dean Milnor Roberts, College of Mines, Univ. of Washington, Seattle, Wash.

UNITED STATES CIVIL SERVICE EXAMINATION

The United States Civil Service Commission announces the open competitive examination for junior technologist. Applications must be on file with the Civil Service Commission at Washington, D. C., not later than April 9.

The examination is to fill vacancies in the Bureau of Standards, Department of Commerce; in the Geological Survey, Department of the Interior; and in positions requiring similar qualifications, for duty in Washington, D. C., or in the field.

The entrance salary is $2000 a year. Higher-salaried positions are filled through promotion.

The optional subjects are (1) ceramics, (2) paper technology, (3) petroleum technology, (4) rubber technology, (5) textile technology.

Competitors will be rated on general chemistry, elementary physics, mathematics up to and including calculus, and practical questions on each optional subject chosen.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the U. S. Civil Service Board of Examiners at the post office or customhouse in any city.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1930	Des Moines, Iowa
AMERICAN CERAMIC SOCIETY	February, 1930	Toronto, Canada
American Chemical Society	April 29–May 3	Columbus, Ohio
American Electrochemical Society	May 27–29	Toronto, Canada
	Sept. 18–20	Pittsburgh, Pa.
American Foundrymen's Assn.	April 8–11	Chicago, Ill.
American Gas Association (11th Annual Convention)	Oct. 14–18	Atlantic City, N. J.
American Institute of Chemical Engineers	June 19–21	Philadelphia, Pa.
	Dec. 2–4	Asheville, N. C.
Amer. Inst. Mining & Metallurgical Engineers	Oct. 7–9	San Francisco, Calif.
American Mining Congress (Practical Coal Operating Men and Natl. Exposition of Coal Mine Equipment)	May 13–17	Cincinnati, Ohio
American Refractories Institute	May 21	French Lick, Ind.
American Society of Mechanical Engineers	May 13–16	Rochester, N. Y.
	July 1–4	Salt Lake City, Utah
(Annual Meeting)	Dec. 2–6	New York City
American Society for Testing Materials	June 24–28	Atlantic City, N. J.
American Zinc Institute	April 15–17	St. Louis, Mo.
11th National Metal Exposition and National Metal Congress	Sept. 9–13	Cleveland, Ohio
Glass Container Assn. of America	May 1–3	Atlantic City, N. J.
Natl. Assn. of Manufacturers	Oct. 14–16	New York City
Natl. Assn. of Mfrs. of Heating and Cooking Appliances	May 8–9	New York City
Natl. Clay Products Industries Assn.	April 15 or 16	Chicago, Ill.
Natl. Glass Distributors Assn.	Dec. 3–5	Pittsburgh, Pa.
Natl. Safety Council's 18th Annual Safety Congress	Sept. 30–Oct. 4	Chicago, Ill.
Taylor Society	May 1 and 2	Charlotte, N. C.
Third International Foundrymen's Congress	June 10–13	London, England
Twelfth Exposition of Chemical Industries	Week of May 6th	New York City

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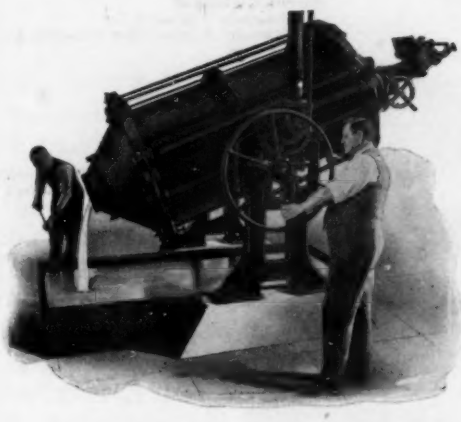

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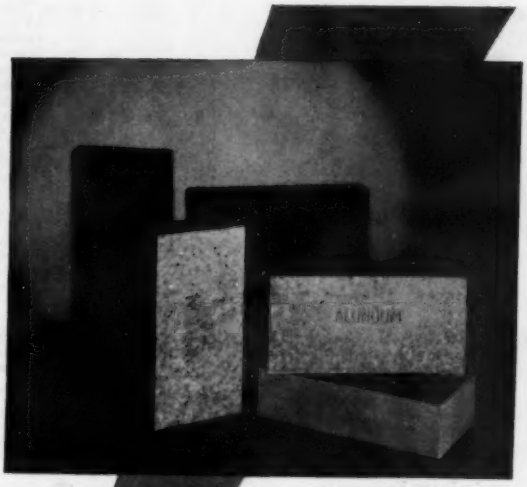

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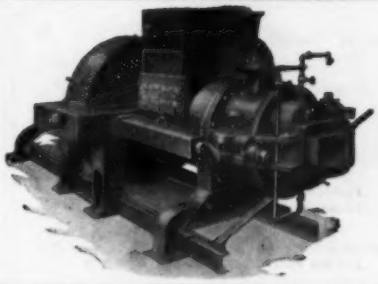

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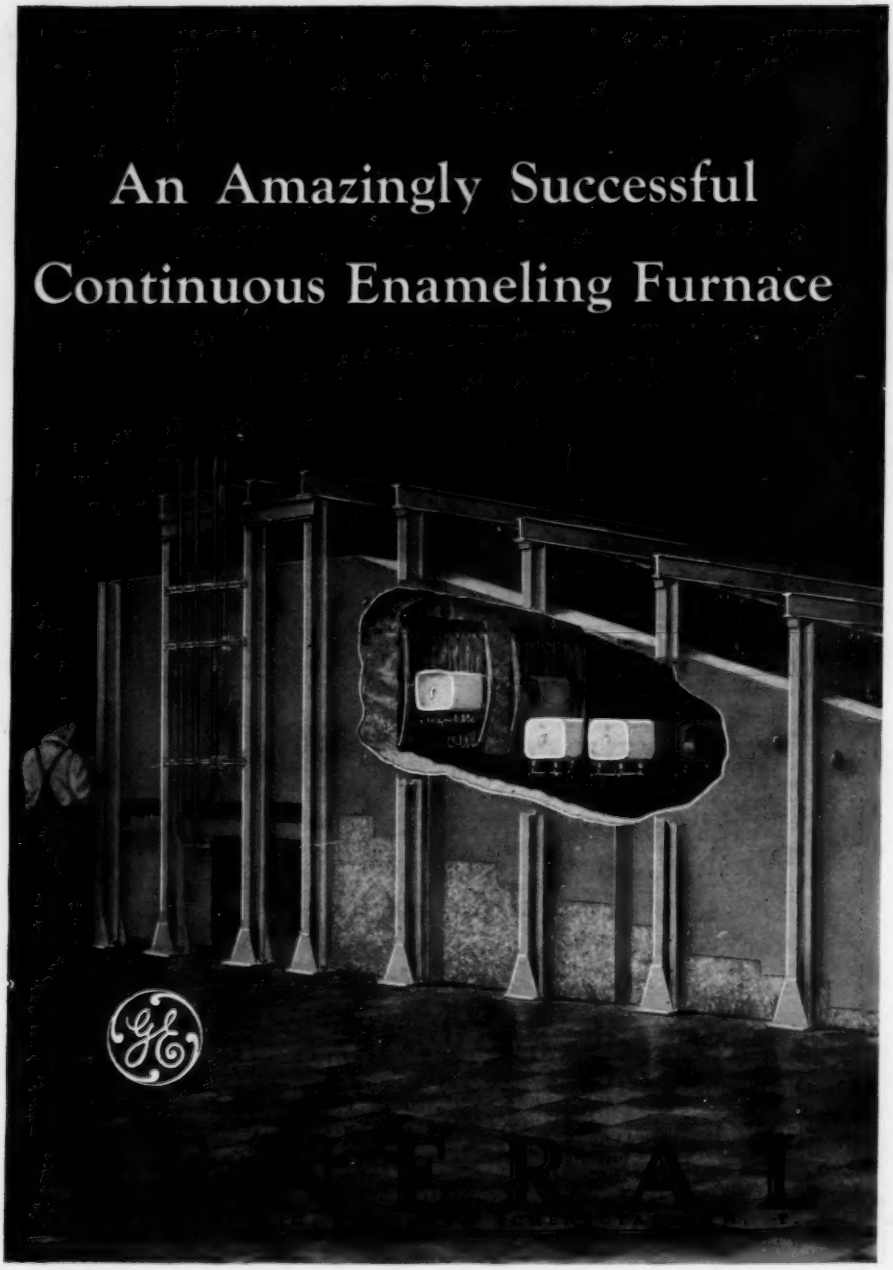
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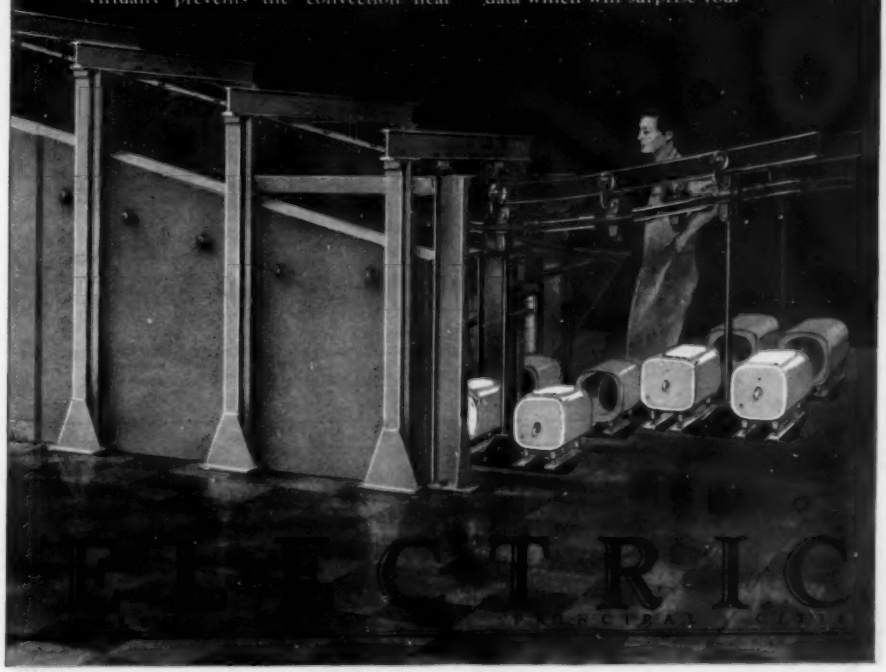

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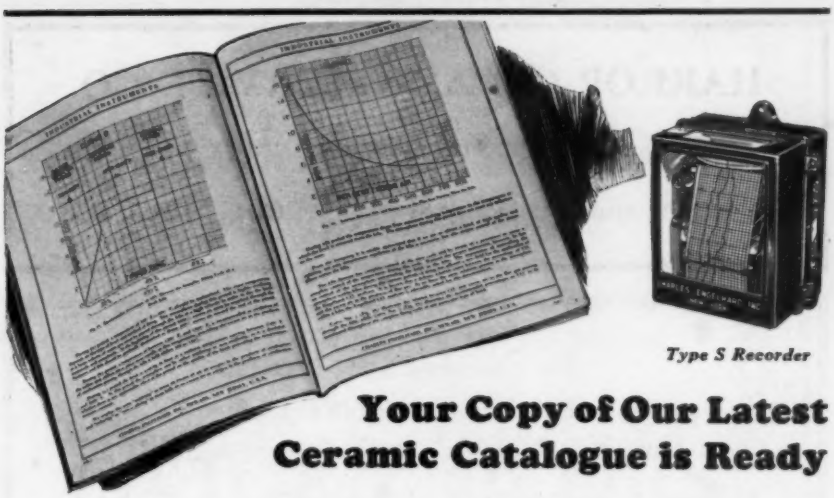

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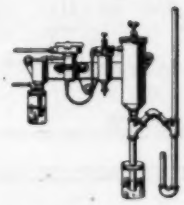

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